THE JOURNAL OF GAS LIGHTING
WATER SUPPLY & SANITARY IMPROVEMENT

VOL. LXXI. No. 1833.] LONDON, JUNE 28, 1898. [50TH YEAR. PRICE 6d.

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FOR
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ALSO
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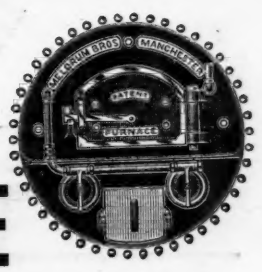

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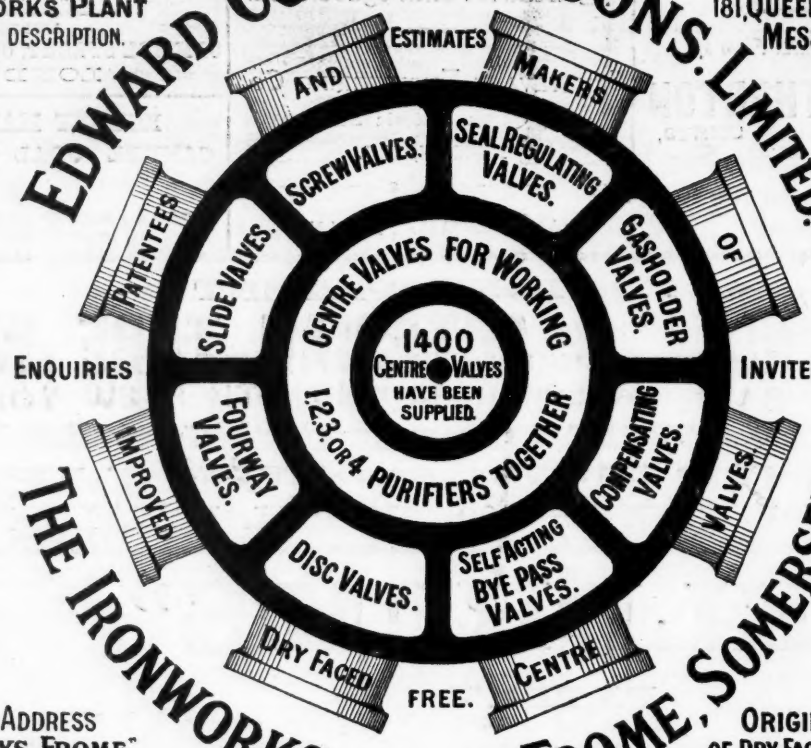

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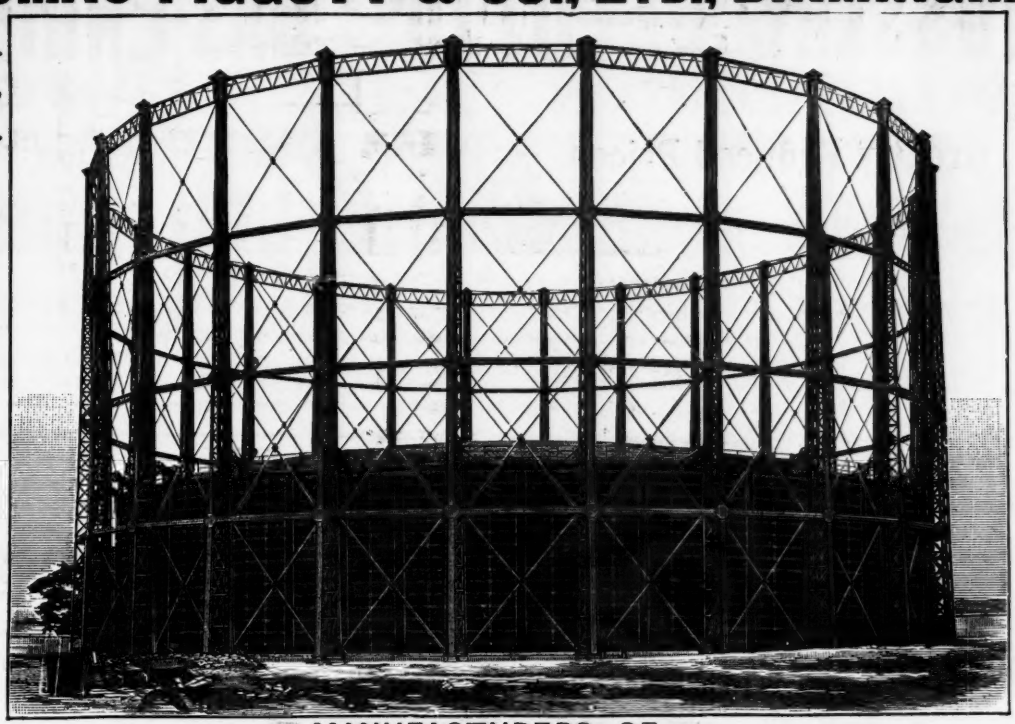

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By R. O. PATERSON, C.E.

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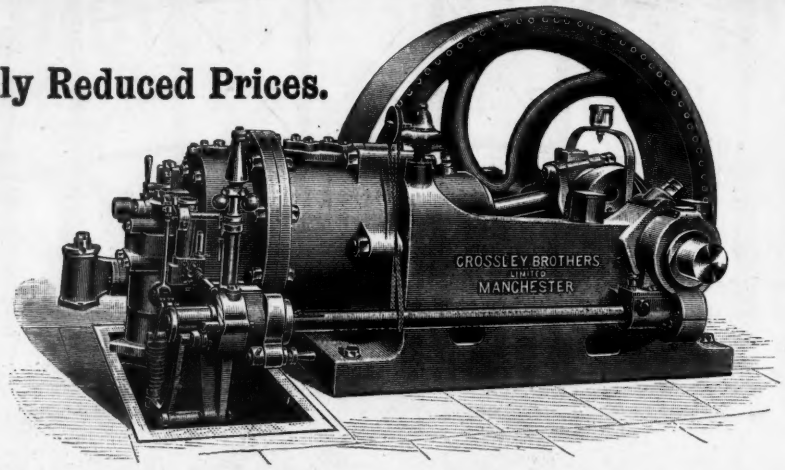

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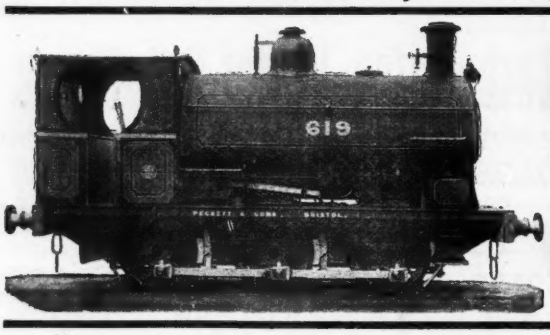

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OVER 60 MAXIM PATENT CARBURETTORS HAVE NOW BEEN FIXED.

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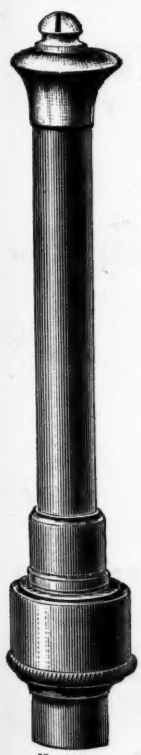

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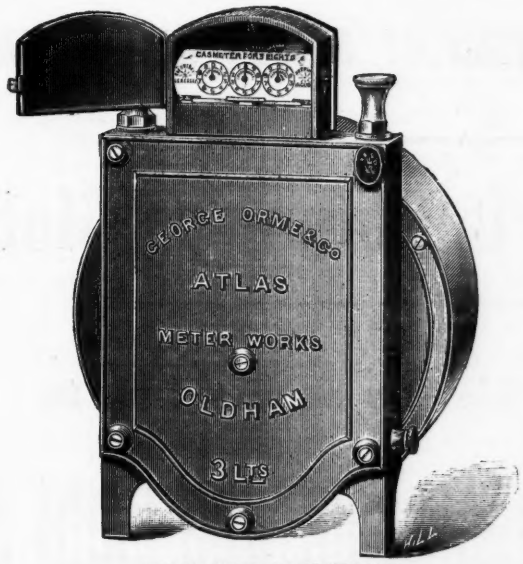
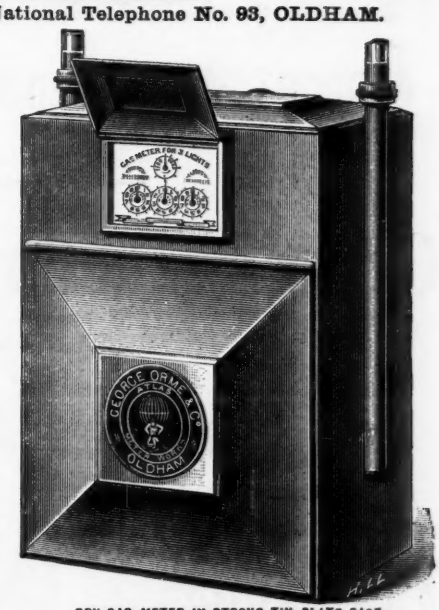


WET GAS-METER IN CAST-IRON CASE.



DRY GAS-METER IN STRONG TIN-PLATE CASE.

ORME'S GAS REGULATOR FOR STREET LAMPS.

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Adopted by the leading London and Provincial Gas Companies. More than 150,000 now in use.

Main Gas Cocks, Pressure-Gauges, & all descriptions of Gas, Water, & Steam Fittings in stock.

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From the 1st of June, 1898, the following REDUCED PRICES will take effect:—

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"C" Mantles **"Gem" Mantles**	**1/-**

PROPORTIONATE REDUCTION OF PRICES IN ALL PATTERNS.

Great Reduction in Chimneys, Globes, &c.

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PIPES and CONNECTIONS, 1¼ to 48 inches in diameter, and make and erect to order RETORTS, PURIFIERS and TANKS, with or without planed joints, COLUMNS, GIRDERS, SPECIAL CASTINGS, &c., required by Gas, Water, Railway, Telegraph, Chemical, Colliery, and other Companies.

Note.—Makers of HORSLEY'S PATENT SYPHONS. These are cast in one piece, without Chaplets; doing away with bolts, nuts and covers, and rendering leakage impossible.

HEATHCOTE GAS COAL.

Rich in Illuminating Power and Yield of Gas. Above the Average in Weight and Quality of Coke.

Maintains a High Standard in Residuals.

THE GRASSMOOR CO., Ld.

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THORNLEY GAS COALS

WORKED BY THE

WEARDALE IRON & COAL Co., Ld.

OUT OF THEIR

THORNLEY AND WHEATLEY HILL COLLIERIES.

Analysis made by

Messrs. J. & H. S. PATTINSON, *May 28, 1895.*

Yield of Gas per Ton . .	10,500 Cub. Ft.
Illuminating Power . .	16·9 Candles.
Coke (of good quality) . .	67·5 per Cent.
Sulphur	0·58 „
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FOR

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For use in the

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Removal of last Traces of SULPHURETTED HYDROGEN in catch position.

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Illuminating Power	38·22 candles
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Yield of Gas per ton	10,500 cub. ft.
Illuminating Power	17·8 candles.
Coke	70 per cent.

SOUTH PELAW MAIN GAS COAL.

Yield of Gas per ton	10,500 cub. ft.
Illuminating Power	16·3 candles.
Coke	73·1 per cent.

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No. 1	Painter .	£25	Single Air Compressor	£17	10
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No. 3	„ .	£35	Double ditto .	£27	0

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Over 200 Plants Sold.

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Hand Compressor and Paint Holder and Sprayer combined, for Stencilling Letters, Ornamental Designs, Decorative Work, and any class of Painting where the work is not very heavy or continuous £20

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NEW POPULAR PRICES.

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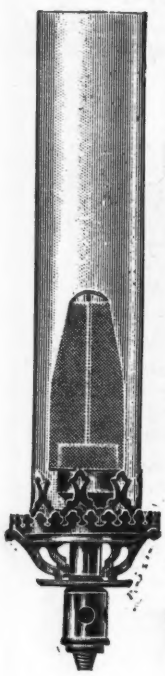

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WITH BYE-PASS, 5/-.

MANTLES

per 9/- doz.

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SUNLIGHT MANTLES

PRODUCE A DIFFUSED LIGHT OF SOFT RAYS,

The NEAREST APPROACH to the LIGHT of the SUN.

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BRASS MAIN AND LAMP TAPS,
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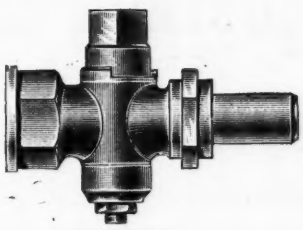
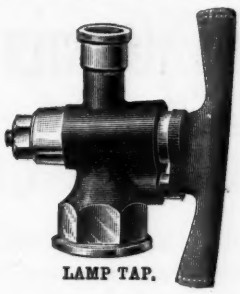
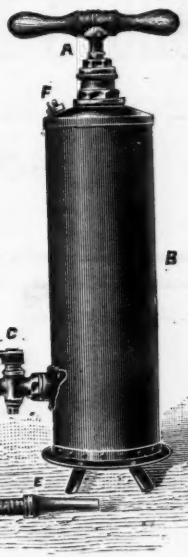
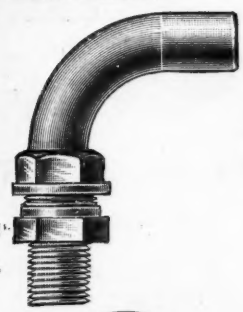
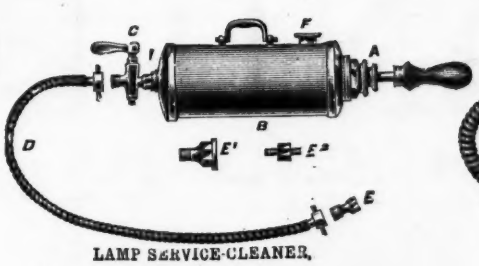

MAIN TAP.

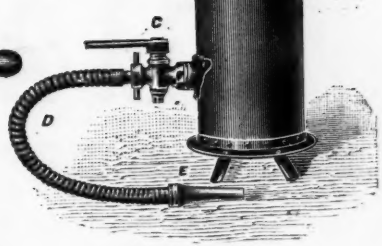

LAMP TAP.



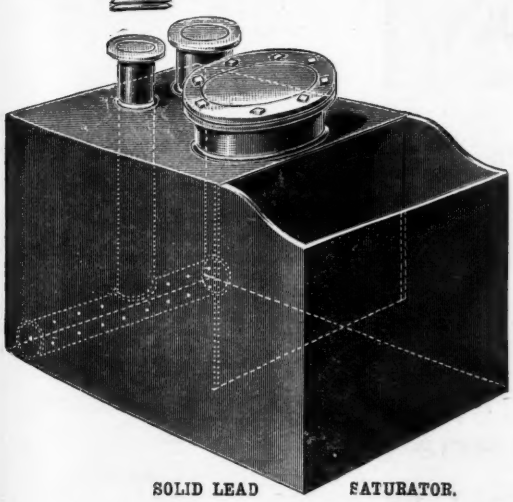


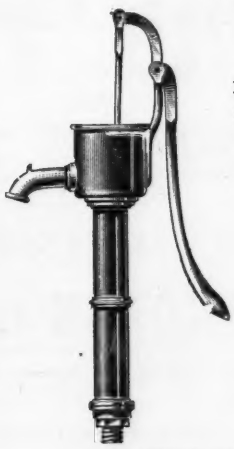


LAMP SERVICE-CLEANER.

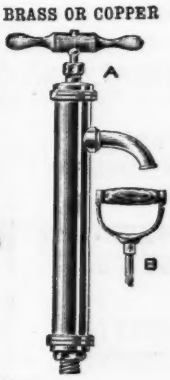


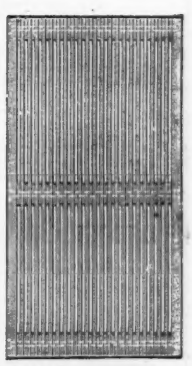
SERVICE CLEANER


SOLID LEAD SATURATOR.


SYPHON PUMPS.

BRASS OR COPPER




IMPROVED WOOD PURIFIER GRID

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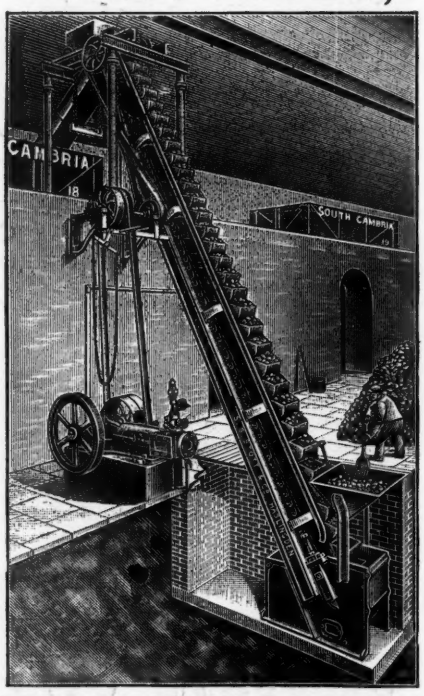

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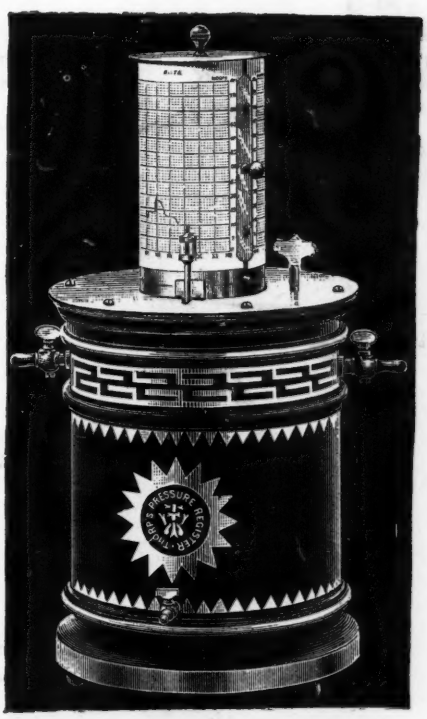

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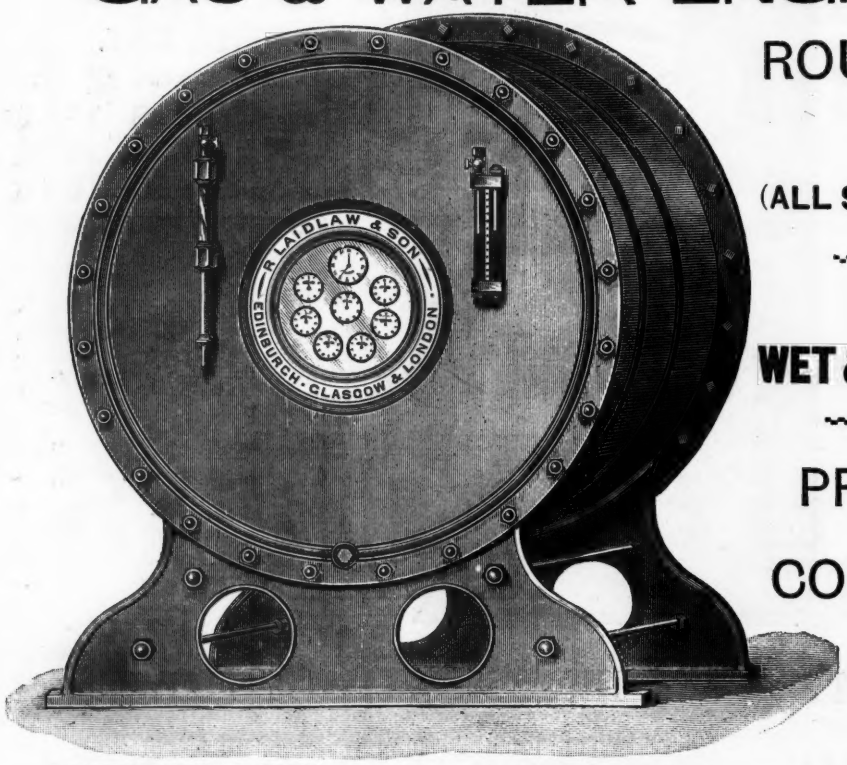

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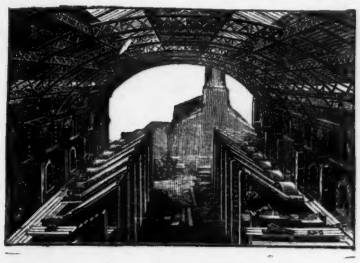

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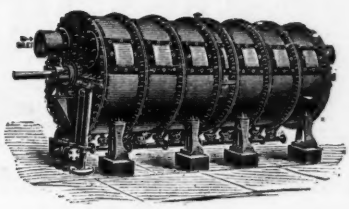

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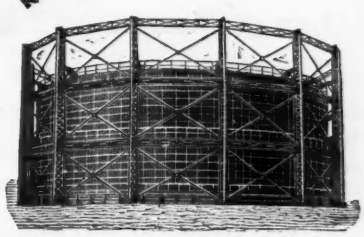

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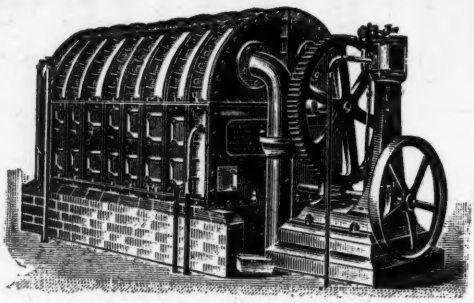

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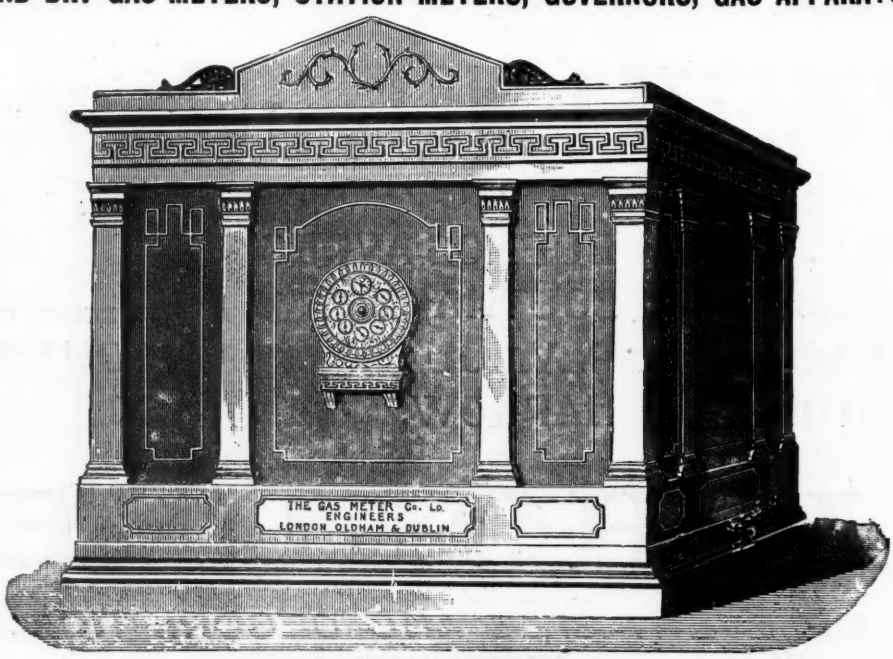

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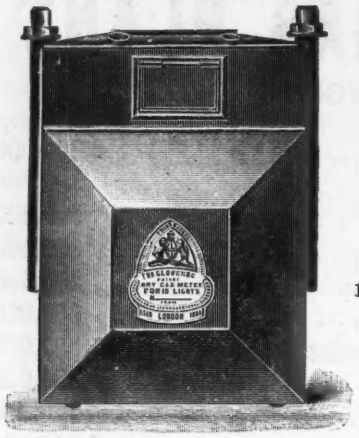

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CONTENTS.

EDITORIAL NOTES:—

GAS, LIGHTING, &c.— PAGE

The Gas Institute Meeting 1527
Committee to Inquire into London Gas Prices 1528
The Petroleum Committee on the Flash-Point 1528
The South Wales Coal Strike. 1529

WATER AND SANITARY AFFAIRS—

Progress of the Metropolitan Water Inquiry 1529
Meeting of the Chelsea Water Company 1529
The Local Government Board and the Protection of Sources of Water Supply—Withdrawal of the Proposed Clauses . . . 1530

THE INCORPORATED GAS INSTITUTE—

ANNUAL MEETING IN BELFAST—

Review of Proceedings 1530
Report of Proceedings—
A Welcome to the Institute; Confirmation of the Minutes; Appointment of Scrutineers; The Report and Accounts . . 1532
Awards of Premiums; President's Address; Reading of Papers; The Benevolent Fund; Report of the Scrutineers; New Members; An Honorary Member; Place of Next Meeting . 1533
Votes of Thanks. 1534
Papers and Discussions—
Lecture—Acetylene and its Modern Developments. By Vivian B. Lewes, F.I.C., &c.. 1534
The Valuation of Gas-Works for Assessment. By W. Newbigging, of Manchester. 1540
The Workmen's Compensation Act, 1897, as Affecting Gas Companies. By C. Stafford Ellery, of Bath. 1544
Standardizing of Meter Unions. By R. S. Carlow, of Arbroath 1551

INSTITUTION OF GAS ENGINEERS:—

GENERAL MEETING IN LONDON—

Papers and Discussions (*concluded*)—
The Pentane Ten-Candle Standard Lamp. By Professor A. Vernon Harcourt 1551
A Two-Candle Standard. By E. Llewellyn Pryce, of Birmingham 1553
A New Departure in Carbonizing, having for its Objects the Prevention of Naphthalene Troubles, and the Providing of Cheap Enrichment. By S. Glover, of St. Helens, and T. Glover, of West Bromwich 1559
Washers and Scrubbers. By E. A. Harman, of Huddersfield. 1565

ESSAYS, COMMENTARIES, AND REVIEWS:—

Gas and Water Companies in the Stock Market 1571
Hints on Coal Carbonization and Fuel Gas Utilization 1571

COMMUNICATED ARTICLES:—

Photometric Standards. By W. Grafton, F.C.S.. 1573
The Gasholder Tank at Sutton. By F. S. Cripps, Assoc.M.Inst.C.E. 1574

TECHNICAL RECORD:—

The Theory of the Incandescent Gas Light 1570
Western (U.S.A.) Gas Association—Annual Meeting at Detroit . 1575
The Decomposition of Gas Oils, Phenols, and Creosote by Heat. 1575
Dr. Percy F. Frankland on the Chemical and Bacteriological Examination of Water 1577

CORRESPONDENCE:—

The Accident Fund of the South Metropolitan Gas Company. . 1579
The Position and Prospects of Incandescent Gas Lighting . . 1579
Income-Tax Assessment 1580
An Object-Lesson in Municipal Gas Supply 1580

PARLIAMENTARY INTELLIGENCE:—

House of Lords—Progress of Bills 1580
House of Commons—The Protection of Sources of Water Supply; Metropolitan Gas Companies' Charges; Progress of Bills . . 1580

LEGAL INTELLIGENCE:—

High Court of Justice—Chancery Division—Grand Junction Water-Works Company *v.* Hampton Urban District Council . 1581
High Court of Justice—Queen's Bench Division—
Elliott *v.* Ludlow Union Gas Company 1581
Hughes *v.* Erith Urban District Council 1581
Shoreditch County Court—Claim for Damages Caused by an Explosion 1581
The Liverpool Corporation and the Water Supply of Prescot. . 1582

MISCELLANEOUS:—

Edinburgh and Leith Gas Commissioners—The Annual Accounts 1582
Meeting of the Plymouth and Stonehouse Gas Company . . . 1582
Workmen's Compensation—Insurance as to Profit-Sharing . . 1583
The Wages of Gas-Fitters and Lamplighters. 1584
Electric Lighting Notes 1584
Bristol Corporation and the Water Works 1585
Metropolitan Water Supply Commission—Twenty-sixth Day . . 1585
Meeting of the Chelsea Water-Works Company. 1587
The Local Government Board and the Protection of Sources of Water Supply 1588
Gas and Water Companies' Stock and Share List 1588
Notes from Scotland 1589
Current Sales of Gas Products 1591
Coal Trade Reports 1592

PARAGRAPHS:—

OBITUARY: Mr. Henry Matterson; Mr. R. Townend Martin; Mr. James Peto; Mr. Joshua Garside Wilson; Mr. T. Dyne Steel; Mr. Edward Fottrell; Sir James N. Douglas 1572
PERSONAL: Mr. W. White; Mr. F. W. Dobson; Mr. J. T. Byrom; Mr. A. Thomas; Mr. W. A. Winter; Mr. John Miles; Mr. Thomas Newbigging 1572
Stagg's Pressure and Exhaust Gauge 1551
The Action of Coal Gas on Storage Cylinders—The Temperature and Strength of Metals 1570
Lamp Black from Acetylene Gas 1572
Acetylene Gas Manufacture in West Prussia 1576
Fylde Water-Works Purchase Scheme—Wolverhampton Public Lighting 1580
Mansfield Corporation New Water-Works 1588
Water and Drainage Works for Callao—Cowes Gas-Works Purchase 1591
Johannesburg Water-Works Company, Limited 1592
New Joint-Stock Companies—A New Reservoir for Bangor—Leamington Water Supply—Blaenavon District Council and the Water Supply—Sales of Stocks and Shares—A Concert in a Gasholder Tank 1593
Improvements at the Tunbridge Wells Water-Works—Coventry Corporation Water Supply. 1594

EDITORIAL NOTES.

The Gas Institute Meeting.

THE Gas Institute held a very successful meeting in Belfast last week. This was the second visit of the Institute to the commercial capital of Ireland within five years; and it had been regarded as doubtful whether the attendance would be good, since Belfast is a long way from some parts of England which are strongholds of the Institute. Moreover, the courteous act spontaneously agreed upon by the Council, in postponing the date of the meeting until the week in which quarter-day occurs, rather than clash with the Institution meeting, prevented many of the members from attending. The event, however, proved that the bonds of loyalty to the Institute, the personal popularity of the President—Mr. James Stelfox—and the programme provided by the labours of the Council and of Mr. Andrew Dougall, the Honorary Secretary, were together strong enough to bring a goodly number of members to the North of Ireland. Still, the fact that doubt respecting the result had existed lends strength to the opinion held by many of the most experienced members that it is time the Institute returned to London, which it has arranged to do next year. Mr. Stelfox approved himself as a model Chairman; and the simple official welcome extended to the visitors by the Lord Mayor of Belfast was all that was necessary in this regard. Not for years has there been a meeting of the Institute at which so little in the way of accessory entertainment found a place in the programme; yet never has an Institute week been more fully occupied. The experiment of holding morning sittings only for the reading and discussion of papers was made a characteristic of the meeting; and it answered admirably. The average attendance of members at these sittings was good; and the length and quality of the discussions were distinctly better than usual, where the nature of the subject permitted controversy. The whole of the arrangements for the meeting worked without a hitch from beginning to end, thanks to the foresight and unremitting attention of the Secretary, Mr. Walter T. Dunn.

While upon this subject, it will not be out of order to suggest that the time has come when some effort should be made to deal with the great and growing evil of the overcrowding of the Institute meetings, and especially of the excursions, by so-called friends of the society, whose room might be preferred to their company. Of course, this is an old grievance, and it is not brought forward here with the intention of raising again the painful question of whether or not "traders" should have a constitutional right to attend the Institute meetings. It has always been recognized here that an organization which pretends to represent the gas industry as a whole, and not merely the professional body of gas engineers and managers, will logically include within its scope whosoever can claim to represent any branch of the industry. But, on the other hand, it cannot be denied that the more completely representative and the more popular such a general organization is, the more unwieldy its meetings are likely to become. Unhappily, also, this overcrowding is certain to show itself more in some ways than in others in connection with the annual meetings. Take it, for instance, that the full member, be he gas engineer or manager, is likely to be more or less interested in every item of the programme—papers to be read and discussed, visits to works, and so forth; not excepting the excursion, which is recognized as offering an indispensable opportunity to those who foregather but seldom to keep up old friendships and form fresh acquaintances. This cannot be the same with the "trader," who, while he may be interested even more directly than the professional man in the subject of some particular paper, would be more or less than human if he had not other and stronger motives for putting in an appearance at gatherings where he meets men who are his customers, without interposition of desk or counter.

We are not now going to rake up anything unpleasant concerning this mixing of professional, or technical, and commercial interests at The Gas Institute meetings. So long as the constitution of the Institute remains what it was made when it was supposed to be "reformed," the formal justification for this blending will continue to exist. It ought to be possible, however, to correct any arrangement of this kind if it is found by experience not to work well; and we wish to do no more than suggest that the

practice of making the Institute meetings, which are convened for one purpose, a rendezvous of people whose objects are different from those of the better part of the members, should be repressed. If Mr. Blank desires to keep up his connection with the Institute for any legitimate reason agreeable to the good of the organization and the comfort of other members, well and good. But if, as unhappily is only too frequently the case, Mr. Blank betakes himself to the meeting with a numerous following of his travellers, with the immediate result of swamping the hotels, overcrowding the excursion, and arousing in trade rivals the burning ambition to "go one better" next time —then, without committing a definite offence warranting his being dealt with by the Council, he becomes a nuisance, and ought to be abated.

If there was any blot upon the Belfast meeting, it was this overcrowding by people who had commercial reasons, and no others, for putting themselves in evidence. The circumstance of most of them being highly respectable individuals, who would scorn to tout for orders on such an occasion, has nothing to do with the question. The single fact that whereas the Council, who expected to have to arrange for about 160 people on the excursion, had to deal at the last moment with a demand for more than 300 tickets, shows plainly that undue advantage is being taken of the organization in this important particular. It is the same with hotel accommodation. Of course, it may be said that hotels are free to all comers at any time, and that it is impossible to prevent one visitor from appropriating the room which but for him would have served for another. But if the following of the Institute continues to swell, it will be a matter of impossibility for those members who desire to preserve their independence to procure sleeping accommodation and food in the localities where this crowd settles down. We believe that something might be done on the part of the Institute Council so as to grapple with this evil. There are time and opportunity now to set about the enterprise; and it is to be hoped that before another provincial meeting takes place it will have been carried to a successful issue.

Committee to Inquire into London Gas Prices.

ANOTHER move has been made by the parliamentary opponents of The Gaslight and Coke Company. In the House of Commons on Tuesday last, on the motion of Mr. Cohen, the member for East Islington, it was resolved: "That a Select Committee be appointed to inquire into "the powers of charge conferred by Parliament on the "Metropolitan Gas Companies, and to report as to the "method in which those powers have been exercised, "having regard to the differences of price charged by the "various Companies." This, therefore, is the first result of the engagement offered by the President of the Board of Trade to Mr. Pickersgill, to "consider" the terms of any proposal for inquiry into the whole matter of the gas supply of North London, as mentioned in these columns a fortnight ago. Mr. Ritchie must be understood to approve the terms of the reference; and it may be taken for granted that the help of the Board of Trade will be freely given to the Committee for the purpose of eliciting the facts. This is the first point that arises in connection with the proposed inquiry. When the Committee, the members of which have not yet been named, get to work, the first witness to be heard will probably be Sir Courtenay Boyle, who will state the law that actually regulates the price of gas in London, and place upon record the results of its operation upon the gas undertakings supplying the Metropolitan area. So much misunderstanding prevails in this regard, that whatever makes for clearer comprehension, even by Members of Parliament, of the truth of the matter, is to be welcomed. The terms of the reference, it will be noticed, are strictly limited. The Committee are charged to inquire into the statutory powers of charge conferred by Parliament upon the London Gas Companies; and to report as to how these powers have been exercised. This is the whole reference; the concluding passage enjoining the Committee to have regard to the differences of price charged by the various Companies being superfluous, because the fact of bringing out the ways in which the powers have been worked by the Companies will show that different rates of charge are in force in the respective areas of the undertakings. The inquiry is also to be historical; and there is no direction to the Committee to suggest anything. Evidently, the framers and supporters of the resolution have been inspired with the desire to present a "platform" of facts, on which agitation may or may not be adequately supported.

The followers of the gas industry, who are perfectly acquainted with the facts thus to be brought out, might imagine that the inquiry instituted for the purpose is not needed, inasmuch as the bare information necessary to satisfy the terms of the reference is readily procurable. But a little reflection upon the difficulty experienced by the general public in understanding the statutory and other aspects of gas supply will support the conclusion that any amount of independent information upon the subject cannot be too much. We have had occasion to comment upon the masterly ignorance of the principal feature of modern gas legislation exhibited by Sir Albert Rollit; and this is capped by an article in the "Speaker" of the 18th inst. The "JOURNAL" is not an organ of party politics; and the "Speaker" is nothing else. It claims to be the weekly Review conducted in the interest of the Liberal and Radical Party, and, as such, rarely touches any matter of current interest without endeavouring to manufacture from it "capital" for the benefit of the party now in opposition. This is what it has tried to do with the situation created by the advance of price by The Gaslight and Coke Company, which is hailed as one of several "signs of an im-"provement of Liberal prospects in the Metropolis." The reason assigned is that the advance is an abuse of the monopolistic powers of the Company which is bound to swell the popular case against all the remaining "mono-"polies," of which the present Government is asserted to be the friend and protector. The history of the gas legislation of London is given, in a garbled shape, with the object of proving that "these high charges are entirely "contrary to the spirit" of such legislation. It is conceded that the Gas Companies "might raise the price if "they took a smaller dividend;" yet the assertion immediately follows that "in 1890 some means were found of "evading the sliding-scale restriction, and the price was "raised to 2s. 9d." Passing on to the Company's Bill of the present session, it is alleged of the stock-conversion scheme contained in this measure that, "as a matter of "fact, such a concession would largely increase the price "which the community would have to pay for the gas "undertaking whenever it chose to municipalize the gas "supply." If this mistake—to call it by no harsher name —can be still persisted in by the "Speaker" after the explanation that was offered in the House by the Chairman of the Committee who passed the preamble of the Bill, one wonders whether the facts to be elicited by Mr. Cohen's Committee will receive more respectful treatment. The "Speaker's" justification for attaching political importance to the rise in the price of gas in North London is that "everywhere there is loud complaining, but nowhere are "the murmurs deeper than in the bye-ways of London, "over the miles of buildings where the working class and "small tradesmen live, and know to their cost what the "increased price of necessaries means." More's the pity that dearer gas should feed the flame of discontent with the established order of things Metropolitan.

The Petroleum Committee on the Flash-Point.

THE Petroleum Committee have settled, so far as their powers go, the knotty question of the "flash-point" of burning oil. When we left the subject last week, the Chairman of the Committee, Mr. Jesse Collings, had carried the majority with him as regards the general tenour of the proposed report; but there remained to be disposed of the questions of the flash-point, and also of what additional measures, if any, should be recommended for dealing with the storage and transport of burning oil. The Chairman was in favour of retaining the existing flash-point—73° (Abel test)—as the dividing-line between petroleum oil and petroleum spirit. He has failed to convince the Committee to accept his view of this matter; they having decided, by a vote of eight to six, to recommend the raising of the flash-point for burning oil to 100° Fahr. Seeing that the Chairman did not vote, this is tantamount to a bare majority of one vote for condemning the present flash-point, which means that the recommendation has no moral force whatever. It is stated that it would have been possible to secure a unanimous vote in favour of the adoption of some middle course, such as the raising of the flash-point to 85° or 90°. But the high-flash party would not hear of any compromise.

It is very unfortunate that such partisans as some of the

members of the Committee have proved themselves to be should be placed in such a position. As the Chairman has shown, not even at the close of the inquiry do all the members distinguish clearly between the idea of a flash-point as marking the limit of safety in connection with the use of oil as an illuminant, and the same thing as merely supplying a convenient dividing-line between petroleum oil and petroleum spirit. The present flash-point was fixed solely to make a distinction between a fluid which, on account of its high volatility, was held to require statutory precautions in respect of storage and handling, and a fluid of similar origin which did not need special care of the kind. From this the idea became surcharged with the totally different notion of the safe use of the fluid for burning in lamps. The fact is that the flash-point of any kind of oil has nothing to do with its capabilities as an illuminant. There is no such thing as a safe flash-point, which is a feature that varies with different descriptions of burning oil as the result of arresting the process of refining at different stages. It is a great pity that the commercial consequences likely to flow from altering the flash-point as recommended by the Committee are left so undefined. Nobody is clear as to whether or not it is to make lamp-oil dearer. Upon this head the experience of the London County Council ought to be available. They have asked for tenders for their new supplies of lamp-oil at their own fancy flash-point of 105°; but with what effect upon the price has not yet been made public. Perhaps somebody interested in the subject will get this out.

The South Wales Coal Strike.

THE deplorable South Wales colliers' war was discussed on Friday last in the House of Commons on a motion for the adjournment of the House submitted by Mr. Brynmor Jones. Unlike most debates of the kind, it proved to be a very reasonable and fair discussion of the matter. As was to have been expected, Mr. Jones and his supporters did their best to make out that the strikers are not responsible for the quarrel, which, as he said, "had caused, and "was causing in an increasing degree, immense misery to "thousands of families, especially to women and children; "which was disturbing commercial operations of great "magnitude, which was inflicting great losses on persons "whose capital was invested in the coal industry, and "which threatened to retard for a long time the progress of "a very large and important part of the United Kingdom." It was argued that if something was not soon done to terminate the dispute, it would be certain to extend. Mr. Jones confessed that the issues between the parties in the beginning were not quite clear; but he was determined that the employers should not have a leg to stand upon. Also, he blamed the Government for sending a military force into the disturbed region. In reply, the President of the Board of Trade, speaking for the Government, declared that, much as they sympathized with all concerned, they could not interfere with offers of conciliation until they were asked. This has not been done. The parties have come together for the consideration of their differences; but, unfortunately, the discussions that have taken place have not resulted, up to the present, in any progress towards peace being made. Meanwhile the Department is waiting.

It is a satisfactory sign of growing wisdom that nobody has been anxious to pose as Conciliator in this case. It is generally thought that what has been called "conciliation" in times past has done much more harm than good; and the present debate ended by the withdrawal of Mr. Jones's motion, with the understanding that the good offices of the President of the Board of Trade will be at the disposal of the parties so soon as, but not before, they are asked for. This is as far as any public discussion of the trouble can be expected to go. It is not a hopeless outlook. It is a great gain that Parliament and public opinion should perceive that, so long as an industrial dispute is upon a matter of principle, the parties must be left to settle by themselves which principle is to prevail. When this point is disposed of, there is a chance that, in the re-settlement of details, the impartial help of an outsider may be acceptable to both parties. After all, however, the details are subjects of after-consideration, which even the principal parties to a dead controversy might be trusted to handle with due regard for each other's susceptibilities. Signs multiply to indicate that the South Wales and Monmouthshire colliers have nearly had enough of the strike; and when they go in it will be on the masters' terms.

WATER AND SANITARY AFFAIRS.

WE are glad to find Mr. Littler, Q.C., the Chairman of the Middlesex County Council, re-appearing before the Royal Commission on Water Supply, and giving a more moderate tone to his views respecting the right of Middlesex to a command of the Thames supply. Mr. Balfour Browne put the question to him: "You are absolutely against more "water being taken from the Thames or from the county "of Middlesex?" The question was substantially warranted by the nature of Mr. Littler's evidence a week earlier; but he nevertheless met it with a distinct negative—adding the explanation, "I am against water being taken from the "Thames beyond the existing quantity, so long as sufficient "water is not left for the county of Middlesex." Mr. Littler, as we signified last week, is perfectly justified in contending that Middlesex should have its wants duly supplied; but he went to the length of requiring that, although Middlesex had enough, London should take only what it was already entitled to take, "and no more." The 185¼ million gallons per day which the Companies are now authorized to draw from the Thames was not at any time to be exceeded. We asked, "Why not?" Mr. Littler now says, what probably he intended to say before, "I am in "favour of as much water being taken from the Thames "as can be got without injuring navigation on the river; but "of that water I want it to be perfectly clear that sufficient "is left for my county." Of course, this may be understood to mean that Middlesex is to take what it really wants, and London is to have what is left. Mr. Littler is afraid of a reverse process, by which Middlesex will have to stand second. But this very abstraction of water from the River Thames by the Metropolitan Companies is, as we observed last week, partly to serve Middlesex; three of the London Companies contributing to the supply of water for two-thirds of the inhabitants of the county. Mr. Littler has no need to be afraid of the London Companies. If they take more water from the Thames, it will be partly for the benefit of his *protégés*, who are safe not to be neglected—that is, certainly as safe as anybody else—so long as the Companies exist.

Interrogated further as to the future management of the Metropolitan Water Supply, Mr. Littler maintained his opposition to a Water Trust and to purchase. When asked to suggest some additional form of control, he declined the attempt; saying if a form of control were suggested to him, he would give his opinion upon it. A witness who preceded Mr. Littler, and who was Mr. Leete, the Vestry Clerk of St. Mary Abbotts, Kensington, proposed a form of control calculated to take the entire business out of the hands of the Companies. The proposal obviously went too far, though it was honestly intended, and the witness was giving the views of his Vestry—a body which has more than once expressed its disapproval of purchase, being "in fear of the financial results." The examination of this witness emphasized the fact that a resident in Kensington pays more per gallon for his water supply than a resident in the East of London, though the West Middlesex charges are comparatively low. With rateable value as the basis of charge, the poorer districts have their supply so much cheaper *per quantum* than the richer. This must needs be the case, though Mr. Leete stated that the charges on rateable value in Kensington were much less than for houses of similar rateable value in the East and South-West. But this equality of rateable value does not often occur. One other witness before the Commission last week was a member of the Whitechapel District Board of Works, whose principal statements were little better than a series of blunders, certainly not calculated to assist the Commissioners in getting at the facts.

The district of the Chelsea Company appears to be safe for all time with respect to its supply of water. There are only 400 acres of land left to be built upon in their area; and when this remaining space is covered with houses, the maximum demand for water will be less than 18 million gallons per day, whereas the Company have power to draw 22 million gallons per day from the Thames. Chelsea, therefore, will have no need of any supplemental supply, and will be quite independent of the Yrfon and Towy. This satisfactory state of affairs was referred to by Mr. F. S. Clayton, the Chairman of the Company, in his address to the shareholders at their half-yearly meeting last Thursday.

In respect to storage, the Company have only to raise the banks of their subsidence reservoirs at West Molesey by 5 feet, in order to increase the capacity by about 50 million gallons—making the total content equal to a supply for about fifteen days. According to Major-General Scott, the capacity of the reservoirs for unfiltered water in the case of the Chelsea Company is now equal to a supply for nine days. As the Directors have decided on thus increasing the storage, the Company will be placed in an unexceptionable position in avoiding the introduction of flood water. A new filter-bed is also in course of construction; and use is being made of sea-sand, which the Directors believe will effect a considerable improvement in the process of filtration. Sea-sand is a new ingredient for the purpose; and at present we find no mention of it in Major-General Scott's list of filtration materials being employed by the London Water Companies. "Thames sands" are mentioned in the case of the Chelsea Company, in association with shells and gravel; and the same occurs with respect to the Lambeth Company. Harwich sand enters into the composition of the filter-beds of the Grand Junction, the West Middlesex, and the Southwark and Vauxhall Companies. Every new effort in respect to filtration is a matter of interest, especially now, when the subject is being so prominently brought forward. In one other feature affecting the water supply the Chelsea Company have made such progress that their work will soon be complete. Next September the constant supply will be universal in the district; thus placing the Company on a level with the Grand Junction Company. The East London Company have established the constant service throughout the Metropolitan portion of their parliamentary area. It is only to be hoped that a proper use of house cisterns will be maintained concurrently with the spread of the constant supply. The proceedings connected with the Royal Commission were the subject of a very significant remark from Mr. Clayton, to the effect that the case for the Companies had not yet been presented. There is no doubt the case will be fairly heard, and will produce a considerable impression when it is brought forward; though the Chelsea Chairman confesses himself entirely unable to fix the date of this coming event. We may finally congratulate the Chelsea shareholders on their dividend of 10 per cent., with something on account of back dividends; while at the same time the Company are paying rates and taxes to the extent of 2 per cent. on their ordinary stock—a fact which has its bearing on the question of purchase.

The decision come to by Mr. Chaplin last Thursday, as recorded in our "Parliamentary Intelligence," to withdraw the clauses prepared by the Local Government Board for insertion in certain Water Bills of the present session, with the view of protecting the sources of water supply, was not altogether unexpected. Soon after the clauses were placed upon the paper of the House, notices were given of verbal and other amendments; and the parties specially interested in the Bills selected as the vehicles for bringing the new proposals into operation lost no time in putting forward their objections. The principal portions of the document in which these were embodied will be found in another column; and it will be seen therefrom that the clauses were roundly characterized as "impracticable, in-" effective, vexatious, and dangerous." It was only to be expected that, in view of the alarm caused by the epidemics of typhoid fever at Maidstone and other places, the Local Government Board should seek to prevent the occurrence of similar troubles elsewhere; but we ventured to think—and the opinion was shared by not a few—that the preventive measures proposed were not only inadequate for the purpose, but that the method selected for bringing them into operation was the wrong one. It was an alteration in general legislation that was contemplated; and it therefore seemed only reasonable to expect, apart from any question of precedent, that the change would be effected by means of a Public Bill. This was certainly the view taken by the speakers on Thursday; and, in face of the strongly-expressed wish then expressed, Mr. Chaplin said he deemed it to be his duty to withdraw the clauses. The announcement of his decision was received with cheers. And so the matter ends for this year. Yesterday, however, Mr. H. H. Marks asked Mr. Chaplin whether it was his intention to introduce early next session a Bill dealing with this matter; and, if so, whether it would be applicable to all existing Companies. Mr. Chaplin replied that he was not in a position to make any statement on the subject.

THE INCORPORATED GAS INSTITUTE.

PROCEEDINGS AT THE THIRTY-FIFTH ANNUAL GENERAL MEETING,

HELD AT

THE EXHIBITION HALL, BELFAST, JUNE 21, 22, AND 23, 1898.

Mr. JAMES STELFOX, M.Inst.C.E., President.

REVIEW OF PROCEEDINGS.

ANY doubts that might have been entertained by well-wishers of The Gas Institute as to the expediency of holding this year's meeting in Belfast were dispelled by the appearance of the Exhibition Hall on Tuesday morning last, when the President, Mr. James Stelfox, took the chair, and saw before him a gathering which, in point of numbers, would have done credit to the Institute at any period of its existence. The meeting was held, as announced, in a comfortable hall attached to the Botanic Gardens, and consequently removed a considerable distance from the centre of the city—an arrangement which proved extremely happy and convenient to visitors generally. Some familiar faces were missing from the gathering; and the reported transactions will be found the poorer by the absence of the corresponding names. But, on the whole, the meeting proved to be highly popular. This is the more remarkable, having regard to the circumstance that no adventitious attractions whatever were offered to draw the members and friends of the Institute to the Metropolis of Ulster. The Lord Mayor of Belfast, Alderman Henderson, M.A., J.P., was present at the opening of the meeting, and welcomed the Institute in a good speech, in the course of which the opportunity was taken for testifying to the high position occupied by Mr. Stelfox in the community officially represented by the speaker. This was all, in the shape of local reception, that entered into the programme of the gathering.

After the Lord Mayor's speech of welcome, and the responsive acknowledgment of the act of courtesy on behalf of the Institute, the premiums for last year's papers were awarded; the bestowal of the first premium, with the President's Medal, upon Mr. Stelfox, being much applauded. This part of the programme did not take very long to get through; and the President was able to start betimes upon the reading of his address.

Mr. Stelfox is one of those masters of his profession from whom much is expected whenever he speaks; and the expectation has never yet been disappointed. He is, above all, a pleasant speaker—one who has the knack of saying things in a humorous, and consequently interesting way. This trait appeared early in the address, in the genial description of the mutual relationship between gas and electric lighting. Collecting together Mr. Stelfox's scattered references to this topic, they will be found to supply a complete answer to the complaints that have emanated from some electricians of the treatment meted out to electric lighting by local authorities interested also in gas supply. Because central station electric lighting has not always developed very rapidly in the hands of corporation gas committees to whom it has been confided as a new branch of business, the electrical Press has fallen into the habit of asserting with regard to all such cases that the electric lighting department is starved through the jealousy of the gas interest. Mr. Stelfox, out of his own experience, exhibits the other side of the picture, and shows that municipal gas undertakings have suffered through the timidity of Corporations whose members have taken too literally the prophecies of electricians respecting the prospects of the two means of lighting. Electric light enthusiasts still assure everybody who will listen to them that gas supply is a dying industry; and accordingly they have only themselves to thank for the cold-shouldering they get from a few partisans of the other side whose regard for gas constrains them from giving any aid or countenance to "the cuckoo in the nest." As a matter of fact, Belfast and Mr. Stelfox have suffered together from the reluctance of the Corporation to

make proper provision for the continuous expansion of the gas supply. Inasmuch as good not infrequently comes out of evil, it is permissible to mention here, as an example of the truth of the saying, that it is to this cause that Belfast owes the introduction of carburetted water gas into the works. Indeed, but for this new resource of the modern gas manager, Belfast might have found itself in sore straits as the penalty of putting trust in the vaticinations of electric prophets.

Contemplation of electric lights suggests to Mr. Stelfox an appreciative mention of the new fashions of gas-burners which have proved so effective in enabling gas to keep its ground and extend its popularity as an illuminant. It is both a just and a graceful act on the part of the President to recall the services rendered to the industry in this regard by an old medallist of the Institute, Mr. Frederick Siemens, whose regenerative gas-burners, as Mr. Stelfox truly says, "have had many imitators, but no superiors." The greatest admirers of the incandescent gas-burner, of whom the President is now one, can well afford to spare a word of praise for an older friend of the industry, which has in many places gone on doing its duty year after year, without needing any attention or repairs. Of course, the President said all that was really needful respecting the new Kern-Welsbach burner, which was made the subject of a special exhibit to the members.

Passing to the subject of gas-enrichment methods, the President noted, from the Olympian height of his carburetted water-gas plant, that the Peebles oil-gas process seems to have "hung fire" of late; while the oxy-oil process, for which Huddersfield was to have become famous, has dropped out of the list of those things that practical men care to know about. But what of Widnes? One would have liked to hear what authority has to say concerning the unique example of gas production offered by Mr. Isaac Carr, to which attention has once more been drawn by the announcement that the price of gas in Widnes has been reduced to 1s. 4d. per 1000 cubic feet.

The President waxed mildly sarcastic over the chequered fortunes of the inclined retort system; and he had but little to say respecting the mechanical stoking of retorts. The influence of carburetted water gas doubtless projected itself into this part of the address, and minimized in the author's mind the relative importance of all other gas-making processes. Particular treatment of the carburetted water-gas question was relegated to the latter part of the address, and constituted by far the most interesting portion of it. Mr. Stelfox manifestly felt at home with this subject, which he handled as if he really loved it. Anticipating a possible query based upon the proverbial saying that "familiarity breeds contempt," the President declared emphatically that in this case increased intimacy has led to increased appreciation. He ranks carburetted water gas as "the greatest and most successful departure from old methods of gas making that has characterized the last decade of the century;" and he marshals gleefully a mass of evidence intended to justify the conclusion. As to this, it need only be said that where Mr. Stelfox appeals to the converted, of course he will command unreserved acquiescence. But he is a little too much of a headlong partisan to win converts from the opposition. We could have wished that the President, whose solicitude to prove the case for carburetted water gas from the gas manager's point of view was extreme, had more plainly shown what advantage the consumer gets from its adoption. He made light of the "cry" against this description of gas upon the score of danger to life; and possibly this is the best way to deal with the question. He even went so far as to claim that, "used as an illuminant, carburetted water gas is hygienically superior to the other;" from which the obviously logical corollary is that the more the public get of it the better, as it is impossible to have too much of a good thing. Is Mr. Stelfox prepared to go to this length? If not, why not? His reasoning that people must put up with the dangers of civilized life is much more plausible than convincing as a plea for the general acceptance of carburetted water gas. Doubtless, the responsible head of the Belfast Gas Department is justified in loving carburetted water gas; but what are its chief recommendations for the public and the consumer? This is the question that Mr. Stelfox does not directly answer. A brief discussion of the potentialities and prospects of uncarburetted water gas fittingly brought to a close a most interesting and instructive address.

The complimentary vote of thanks to the President for his address was moved, in appropriate terms, by Mr. W. Hardie, and seconded by Mr. J. M'Gilchrist.

The first paper taken was that of Mr. W. Newbigging, on gas-works assessment, which elicited a good deal of discussion. Mr. Shadbolt then read his paper on "Village Lighting," which carried the meeting on to the time of adjournment for the day. In the afternoon, most of the members accompanied the President on an inspection of the great shipbuilding establishment of Messrs. Harland and Wolff.

Wednesday's business began with Professor Lewes's lecture on "Acetylene," which proved a great attraction. It was followed by the discussion of Mr. Shadbolt's paper, read on the previous day. It turned out to be somewhat more controversial than the text of the paper promised. Mr. H. Green, of Preston, then read his valuable contribution, describing his unique system of purifier construction, which was particularly interesting to those of his audience who remembered the publication of a notice of the Preston practice in the "JOURNAL." Mr. Green was warmly supported by Mr. Stelfox, who avowed the success which had attended his own adoption of the system of tightly-closed purifiers in connection with carburetted water-gas manufacture.

Mr. C. S. Ellery's paper on "The Workmen's Compensation Act" was read by Mr. A. Dougall, the Honorary Secretary, in the absence of the author. This was a carefully prepared commentary on the provisions and probable working of the Act, from the point of view of the employer of labour in gas manufacture. It was followed by a most helpful discussion, which had to be adjourned till the next morning.

In the afternoon, the President and a large contingent of members visited the head-quarters station of the Corporation Fire Brigade, where the Superintendent, Mr. G. W. Parker, showed the excellent arrangements of the establishment, which is quite new; and ordered several "turns-out" for the gratification of the visitors. The display was greatly appreciated; the smartness of the response to the call, when in one instance only 10½ seconds elapsed between the sounding of the alarm and the exit of the horsed and manned salvage car, being duly admired. Afterwards the Corporation Gas-Works were inspected.

One of the attractions of Belfast during the Institute week was the exhibition at the Ulster Hall of the new burners and lanterns, both for interior and public lighting, brought out by the Welsbach Company. The arrangements were under the personal supervision of Mr. J. H. Sheldrake; and the exhibition was visited by numbers of the townspeople and the members and friends of the Institute. For the convenience of the latter, Saturday was set apart in order that the special features of the exhibits might be examined at leisure.

On Thursday morning, the discussion on the subject of Workmen's Compensation was continued, and kept up with much spirit and point. Indeed, this treatment of the most topical of the questions brought before the Institute was the best feature of the whole meeting. A mass of information was elicited; and the character of the discussion was uniformly high. Moreover, it was abundantly shown that gas managers are disposed to deal more benevolently by their workpeople than the strict letter of the law enjoins.

Mr. S. Y. Shoubridge's paper describing the inclined retort installation at Salford was afterwards taken, and proved to be a sweeping claim for the super-excellence of this system of carbonizing coal; and it was, of course, quite as warmly challenged. This discussion also was most lively and businesslike. From these remarks, it may be inferred that the Thursday morning sitting touched the high-water mark of the meeting; and this inference would be correct. The inclined retorts came very well out of the ordeal—almost too well, indeed, because the advocates of the alternative practice had very little to say for the older plan that has not been heard before.

Mr. R. S. Carlow's paper on meter-unions followed, and the meeting signified its appreciation of the matter by the passing of a sensible resolution on the subject. This terminated the technical business of the meeting; and the formal votes of thanks needed to wind up the transactions of the Institute for the year were quickly passed. A very important matter—the selection of the place of meeting next year—was disposed of by the unanimous selection of London; the general feeling being that the Institute had been too long away from the Metropolis. This opinion

was supported by the incoming President—Mr. S. Stewart, of Greenock—who, while fully testifying to the desire of the Scottish members to welcome their professional brethren to Scotland, agreed that the best interests of the Institute constrained its return to London.

The excursion on Friday was to Newcastle, Rostrevor, and Warrenpoint—returning to Belfast after a full twelve hours of varied "outing." The arrangements for the trip were capitally conceived, and successfuly carried out; the visitors' appreciation of the objects of interest met with *en route* being greatly enhanced by the explanatory pamphlet written to this intent by Mr. Stelfox.

So ended a very successful meeting, for the pleasant conduct of which the popular President is to be gratefully remembered by all who took part in the proceedings.

REPORT OF PROCEEDINGS.

The Thirty-fifth Annual General Meeting of the Institute was held on Tuesday, Wednesday, and Thursday of last week, in the Exhibition Hall, Botanic Gardens, Belfast. The Right Hon. the Lord Mayor of Belfast (Alderman James Henderson, M.A., J.P.) took the chair to open the proceedings.

A Welcome to The Institute.

The Lord Mayor assured the members that both himself and the Corporation were delighted to know that the Institute had again come to Belfast. There was not a member of the Corporation who had not the highest respect for their excellent President, Mr. Stelfox; and in working with the Gas Committee, though occasionally a little wave might ruffle the surface of the otherwise calm exterior of his mind, he was sure he would agree that, as a rule, the Committees he had had to work with since the gas supply was taken over by the Corporation had discharged their duties with a desire to make their magnificent gas undertaking a success. As many present were aware, the gas-works were purchased by the Corporation in 1874; and it was very interesting to him to remember that his father was then Mayor of Belfast. From that time onwards, with the excellent assistance of Mr. Stelfox and the really marvellous progress of the city, of which they were justly proud, the undertaking had proved itself, if not the first in the world (which some of them hoped it was), at any rate a magnificent concern which deserved all praise. The price paid for it was £432,000; and the extent of ground now covered by the works was almost 15 acres. They had six holders capable of containing 6,500,000 cubic feet of gas; the largest holding 2,600,000 cubic feet. It stood 106 feet high; and in the construction of it 1500 tons of iron were used. The consumption of gas in 1874 was 416 million cubic feet; and was now 1500 millions. In 1894, the Manager had the very greatest difficulty in supplying the enormous quantity of gas required; but, being a man who always took advantage of every improvement, he very properly started a carburetted water-gas plant, which had assisted in the most marvellous manner in meeting the great increase in the demand for gas. One other fact of great interest was that the consumption of coal had been reduced by something like 50,000 tons. Of course, he was not well up in the subject of the manufacture of gas; but if anyone wished to know exactly how this new system worked, he was quite sure Mr. Stelfox would explain it very clearly, and in a very few words. In the extension of mains the Corporation had expended upwards of £95,000; but, notwithstanding all the improvements which had been made, and the valuable plant erected since 1874, the debt on the works at the close of the last financial year was only £354,000. Those who were fond of statistics would agree that these figures were worth recording; and it must be borne in mind that this sum included £33,000 which had been taken from the fund for the erection of electric lighting plant. He did not suppose any of his audience would object to this. They were fully aware that gas would remain the most important factor, as regarded both illumination and power; and in comparison with it the new light, with all due respect to it, was merely a toy, though one for which there might be a brilliant future. In his opinion, gas would hold its own, and, under the magnificent management of their President, he had not the least doubt that it would always be a source of great profit to the Corporation. He was sorry to hear, when last in London, that the price of gas there had been increased; but in Belfast they had a different state of affairs. They had recently reduced the price; and, with the discount allowed on the accounts, it worked out to only 2s. per 1000 cubic feet. It was an excellent light, when the fittings and meter were in good condition. But, unfortunately, many gas consumers did not attend to these matters; and some of them went in for lamps, candles, and other absurdities, because of what they called the wretched light given by the gas, without taking the least trouble to see the fittings were in order. The Corporation made no charge for meters; and they had two kinds—dry and wet, the latter being naturally, in Ireland, the most favoured. They had an excellent staff of officers; Mr. Alexander Turnbull (who was almost as grey in the service of the Corporation as Mr. Stelfox) being head of the Financial Department. He might say the information he had given to the members was not derived from Mr. Stelfox; for when he (the Lord Mayor) wrote to him a few days previously asking about some of the matters he had brought forward, his reply was that he would leave the matter entirely in his hands. The only point on which he had received some information from Mr. Stelfox, which he thought would be very interesting, was as to the total surplus on the gas-works since 1874; and this he found was something like half a million sterling. This was a large figure; and when one remembered that the city had been constantly increasing until it had now 350,000 inhabitants, that the area had extended by 15,000 acres, and that the gas supply had never run short, this result was very satisfactory both to the Manager and to everyone connected with the works. He was pleased to hear that nearly 300 members of the Institute had come to Belfast; and he could assure them all a hearty welcome. He was always pleased to see strangers, because, though in Belfast they had made marvellous strides, they were not so perfect as they might be; and he was fully persuaded that all those who were welcomed in Belfast would be equally ready, in their own towns and cities, to reciprocate the same good feeling. He was told the Institute contained 700 members; and he was sure that, in the hands of such capable men as he saw before him, they had all the necessary funds for old age, sickness, and so forth—that, in fact, they had done everything in their power to make the Institute a success. He was very pleased to see so many present; and he could assure them that if they accepted the guidance of Mr. Stelfox and those whom he had asked to assist him, they would not go away disappointed.

Mr. Stelfox, in the name of the Institute, thanked the Lord Mayor for his kindness in coming, at some little inconvenience, to welcome the members. He also took the opportunity of thanking the Corporation for granting the Institute the use of the hall for the meetings, as it had relieved them of some little difficulty.

The Lord Mayor then retired, and Mr. Stelfox took the chair.

Confirmation of Minutes.

The minutes of the previous meeting were taken as read, and confirmed.

Appointment of Scrutineers.

Mr. J. J. Runton (Hull) and Mr. D. T. Livesey (East Grinstead) were appointed Scrutineers of the ballot-papers for the election of office-bearers and new members.

The Report and Accounts.

The Secretary (Mr. Walter T. Dunn) then read the report of the Council, which was summarized in the "Journal" for the 31st ult. (p. 1252).

Mr. W. A. Valon (Ramsgate) moved the adoption of the report, which he considered to be eminently satisfactory, especially as the accounts showed a credit balance of upwards of £170.

Mr. T. H. Martin (Barnet) in seconding the motion, suggested that the time had come when the Council might again consider the advisability of applying to Gas Companies and Corporations for assistance in carrying on the work of the Institute. There were 443 ordinary members, whose subscriptions formed the great bulk of the income; there being only 43 or 44 Corporations and Gas Companies who assisted. Many important matters of research were, he said, kept back for want of funds.

Awards of Premiums.

The premiums for papers read at the last meeting were then awarded, as follows:—

First Prize (with the President's Medal).—To Mr. James Stelfox, of Belfast, for his paper on "The Claus System of Purification at Belfast."

Second Prize.—To Mr. Isaac Carr, of Widnes, for his paper on the "Taxation of Gas by Local Authorities."

Third Prize.—To Mr. W. R. Chester, of Nottingham, for his paper on the "Automatic Regulation of Pressure in the Distributing Mains."

Mr. S. Stewart (Greenock), the Senior Vice-President, presented the first prize.

The President, having expressed his thanks, presented the second prize to Mr. Carr, and stated that the third would be forwarded to Mr. Chester, who had been detained in London by parliamentary business.

President's Address.

The President then delivered his Inaugural Address, which was given in the "Journal" last week (p. 1461).

Mr. W. Hardie, jun. (North Shields), proposed a vote of thanks to the President for his address. He said it must be a great pleasure to him to see so large a gathering, which he thought was in a great measure due to the personal influence of the President, and to the expectations the members had all formed, from previous knowledge of him, of an interesting address.

Mr. J. M'Gilchrist (Dumbarton) seconded the motion; and it was carried unanimously.

Reading of Papers.

The reading and discussion of papers was then proceeded with. These and the lecture were taken in the following order:—

Tuesday.—(1) "The Valuation of Gas-Works for Assessment." By William Newbigging, of Manchester. (2) "Village Lighting: A Comparison." By R. G. Shadbolt, of Grantham.

Wednesday.—(3) "Acetylene: Its Latest Developments." A lecture by Professor Vivian B. Lewes, F.I.C., &c. (4) "The Workmen's Compensation Act, 1897, as Affecting Gas Companies." By C. S. Ellery, of Bath. (5) "The Construction of, and Mode of Working Purifiers." By H. Green, of Preston.

Thursday.—(6) "Inclined Retorts at Salford." By S. Y. Shoubridge, of Lower Sydenham. (7) "Standardizing Meter-Unions." By R. S. Carlow, of Arbroath.

The papers by Mr. W. F. Cotton and Mr. J. T. Sheard, on "The Necessity for Amendments in the Gas-Works Clauses Acts" and "Laboratory Notes: Gas Analysis, &c.," respectively, were taken as read.

We give to-day the papers by Mr. Newbigging and Mr. Ellery, with a report of the discussions thereon; also an abridgment of that by Mr. Carlow—reserving for next week the more strictly technical portion of the proceedings.

The Benevolent Fund.

The Annual Meeting of the Donors and Subscribers to the Benevolent Fund was held at the conclusion of the ordinary business on Tuesday.

The minutes of the last meeting having been read and confirmed,

The report of the Committee was taken as read.

Mr. W. A. Valon (Ramsgate) moved the adoption of the report and accounts.

Mr. J. West (Manchester) seconded the motion, which was at once carried unanimously.

There being no other business, the meeting adjourned.

Report of the Scrutineers.

On Thursday afternoon, the result of the ballot for the election of office-bearers for the ensuing year was declared, as follows:—

President.—Samuel Stewart, of Greenock.

Vice-Presidents.—Edmund Herbert Stevenson, of London; T. O. Paterson, of Birkenhead.

New Members of Council.—F. G. Dexter, of Winchester; James M'Gilchrist, of Dumbarton; T. N. Ritson, of Kendal; J. Davis, of Gravesend.

Auditors.—Alfred Lass, of London; T. H. Martin, of New Barnet.

Hon. Secretary—A. Dougall, of Tunbridge Wells.

Benevolent Fund Committee.—C. Stafford Ellery, of Bath; R. Hunter, of Chester.

New Members.

It was announced that all the gentlemen whose names appear in the following list of applications for admission to the Institute had been approved, and would be duly enrolled; and the transference of five associate members to the class of members was sanctioned by a vote of the meeting.

MEMBERS.

Acland, T., Blaina, Mon.
Anderson, E. E., Ripon.
Ashton, H., Barnstaple.
Bowen, D., Abercarn.
Chamberlain, F. W., Bombay.
Cowley, W., Spennymoor.
Faull, E., St. Ives, Cornwall.
Foster, J., Leigh, Lancs.
Fryer, J., Market Harborough.
Grimshaw, E. G., Calverley.
Hall, J. E., Prescot, Lancs.
Hill, F., Usk, Mon.
M'Cubbin, J., Chorley.
M'Nair, J., Wishaw.
Nicholson, J., Castleford.
Niven, F. A., Rowley Regis.
Paterson, J. J., Carrick-on-Suir.
Pye, J. H., Barbados.
Reid, T. J., Ballina.
Robins, G. M., Sutton.
Thorpe, F., Colne.
Turner, F., Chard.
Wilkinson, J., Drighlington.
Winstanley, F. A., Rotherham.
Wicks, J. F., High Wycombe.

ASSOCIATE MEMBERS.

Canning, J. H., Newport, Mon.
Chandley, S. B., Warrington.
Franklin, E. F., Widnes.
Hutchinson, H., Barnsley.
Kindler, H. K., Stockton.
Morgan, N. H., Rhayader.
Newton, W. H., Langley Mill.
Walmsley, R., Southport.

TRANSFERENCES.

Bancroft, F. G., Hull.
Bond, J., Leeds.
Johnson, F. W., Mossley.
Masterton, A., Edinburgh.
Niven, H., Gomersall.

Mr. Stewart thanked the members for the honour done him by placing him in the chair. He said that, though he could have wished the office had fallen into abler hands, he would do all he could to keep up the standard of the Institute.

An Honorary Member.

The President next formally nominated the President for the current year (M. Vautier, of Lyons) of the Société Technique du Gaz en France as an Honorary Member of the Institute.

Alderman Miles (Bolton) seconded the nomination; and it was at once agreed to.

Place of Next Meeting.

The President said the next business was to decide on the place of meeting for next year. There was a feeling on the part of many that Greenock was the natural place to go to; but other members seemed to think there might be inconvenience or difficulty experienced in finding sufficient accommodation for a large number of visitors, and there was a strong feeling that they should go to London.

Mr. W. A. Valon said what the President suggested agreed not only with his own view, but with that of several members to whom he had spoken on the subject. They had met long enough out of London; and he hoped they would not depart again from the old and wholesome rule of only being one year away from the Metropolis. He would move that the next meeting be held in London.

Mr. T. H. Martin seconded the motion.

Mr. Isaac Carr said they had now been two years away from London, and it would be necessary, he thought, to bring the balance even to have two consecutive meetings in London. Moreover, the second meeting would be almost necessary, on account of the probability of the Institute visiting the Paris Exhibition in 1900.

Mr. J. M'Gilchrist said he feared the feeling was so strong in favour of London that they would not be able to carry Glasgow; but many of the Scotch Engineers would be disappointed if they went to London two years in succession. They had all been looking forward to having a grand time in the "land of the mountain and the flood," where they would have a very hearty welcome, if they could see their way to come.

Mr. Isaac Carr said he had had some conversation with Mr. Stewart on the subject, and had taken the trouble to ascertain the opinions of various members; and they all

seemed to think that, unless Mr. Stewart made out a very strong case in favour of going to Greenock, they should go to London.

Mr. W. W. HUTCHINSON, in supporting the motion, said that he did not think they would really displease Mr. Stewart if it were carried. No doubt if they were to go to Greenock he would see that the thing was done properly; but he was sure he would bow to the wishes of the majority. He did not think they ought to forecast two years in succession, but leave that to be determined next year. He believed he was correct in interpreting what had passed by saying that, out of special compliment to Mr. Stelfox, they had departed from the time-honoured custom of having the meetings alternate years in London; but they certainly ought not to transgress further in that direction.

Mr. T. WILSON (Coatbridge) said he was prepared to move an amendment. He had been talking to dozens of Englishmen, and they seemed to think that they ought to go back to Scotland next year; the more so seeing that the Paris Exhibition was to be in 1900, and that there was no reason why they should meet two years in succession in London. If the thing were virtually settled, he would sit down; but if not, he should like to take the opinion of the meeting.

Mr. STEWART said the real point to be considered was the interest of The Gas Institute, which he was told had suffered by being so long out of London. If this were the case, of course they ought to go back to the Metropolis. He did not think, speaking candidly, that it was in the interest of the Institute to always meet in the town where the President happened to be located; for if they did this, they would hardly ever meet in London. It was better to fall back on the old plan, and meet every alternate year in the Metropolis. Therefore, though he was sorry that they were not to go to Greenock, where they would have been very welcome, they had talked it over among themselves, and decided that it was better not to do so. While he regretted the decision for personal reasons, he and the Council would do all they could in London to make things agreeable.

The motion was then put and carried.

VOTES OF THANKS.

Mr. VALON proposed a vote of thanks to the Lord Mayor and Corporation of Belfast, for the facilities they had afforded to the Institute, especially for the free use of the room in which they had met.

Mr. T. O. PATERSON seconded the motion, which was carried unanimously.

Mr. W. HARDIE next proposed a vote of thanks to the authors of papers. He remarked that these had been well up to the standard; and though some had been of a very controversial nature, and raised points which had not been all settled, the result would, he had no doubt, be in the direction of progress.

Mr. H. WIMHURST (Sleaford) seconded the motion, which was carried unanimously.

Mr. R. G. SHADBOLT next proposed a vote of thanks to the Scrutineers, to whom, he said, it was thoroughly due, as he could testify from having filled the office on one occasion.

Mr. J. W. BUCKLEY seconded the motion; and it was carried.

Mr. H. GREEN next proposed a vote of thanks to the Council of the Institute. He said they all knew that there was no institution in the country which was better conducted than The Gas Institute; and they also knew how much time and care the Council devoted to the work. They had to travel backwards and forwards to the various meetings, which at times must cause them great inconvenience. He had been once or twice asked to join; but he could not see his way to devoting the time required for the duties.

Mr. P. SIMPSON (Rugby) speaking from an experience of some nine years on the Council, concurred it was no light work. Especially now that the Institute was so large, it must entail a very great amount of trouble on the Council. The way in which they carried out the work, however, was satisfactory to all; and they deserved the best thanks of the members.

The motion was carried unanimously.

Mr. ISAAC CARR next proposed a vote of thanks to the President for the able manner in which he had conducted the proceedings. They had, he said, all vividly in mind his Inaugural Address, which would stand out among other similar efforts for many years to come. It displayed throughout the utterances of a master-mind.

Mr. R. WATSON seconded the resolution, saying that the members had looked forward for some years to the presidency of Mr. Stelfox. His present year's address was a masterpiece, and would compare favourably with any that had preceded it.

The resolution was carried by acclamation.

The PRESIDENT, in responding, said he did not feel that he possessed qualities particularly suited to the successfully carrying on of a meeting; but the matter was made easy when everyone showed so much consideration for him. On the whole, they might say the discussions on the papers had been quite equal to any that had taken place at previous meetings. He was grateful to every member of the Institute with whom he had come in contact; and he could truly say he had received from all the greatest courtesy and assistance. If, under these circumstances the meeting did not go well, he wondered how it would go if an opposite disposition had been shown. The success of the meeting was really due to the members themselves; but he thanked them all for the kindness they had shown him.

Mr. W. W. HUTCHINSON then moved a vote of thanks to the Auditors.

The PRESIDENT next proposed a vote of thanks to the Honorary Secretary, Mr. Andrew Dougall. He said it was all very well for the President to preside at the annual meeting; but the Institute was really in the hands of its Honorary Secretary. Now that his responsibility as President ended, he could only say he was profoundly glad to think the Institute was in such able hands as those of Mr. Dougall, whose zeal and attention he had had ample opportunity of becoming acquainted with during his year of office.

Mr. C. A. CRAVEN, in seconding the motion, said he hoped Mr. Dougall would live long to occupy the position he now adorned.

The resolution having been carried unanimously,

Mr. DOUGALL thanked the members for the kind way in which his services had been acknowledged. While the position of Honorary Secretary was, he said, no sinecure, they must remember that somebody else was doing most of the work. It must not be inferred because he sat next to the President all day long during the meeting that he should have the credit for making the arrangements to carry out the work of the Institute. This work had devolved principally on the Secretary, Mr. Dunn—an officer whom they had all found to be most courteous. He (Mr. Dougall) could testify that he was very hard-working; whenever he was busy he was cool and collected; and when work had to be done, it was always done up to time. The Council one and all felt that the more they knew of Mr. Dunn, the more they liked him; and they had lately had an opportunity of showing their appreciation of his services in a way all men liked. They hoped Mr. Dunn would remain with them for a long time to come; and he concluded by proposing a hearty vote of thanks to him.

Mr. S. Y. SHOUBRIDGE, in seconding the motion, said the Institute could not have a more able, zealous, or conscientious officer than Mr. Dunn. The excellence of the arrangements of the present meeting were sufficient testimony to that.

Mr. GREEN also spoke in support of the resolution, which was carried unanimously, and

Mr. DUNN having briefly thanked the members, the proceedings terminated.

THE LECTURE.

ACETYLENE: ITS MODERN DEVELOPMENTS.

By VIVIAN B. LEWES, F.I.C., &c.,

Chief Superintending Gas Examiner to the Corporation of the City of London.

It was at the Edinburgh meeting in 1895, that the attention of the Institute was first directly called to the advent of a new gaseous illuminant far exceeding in brilliancy any of its fellow hydrocarbons, and which, though it had been known for some sixty years, had been so difficult to prepare that no one had dreamt of the possibility of its use becoming a commercial fact. During the three years which have

elapsed between that meeting and our present gathering in the Sister Isle, much has happened to alter the position occupied by acetylene. Reputed dangers have vanished into thin air; and unsuspected ones have taken their place. Many schemes have been proposed; but the Home Office and the Insurance Companies have disposed of the majority of them. The question of cost has descended from the realms of Transatlantic fiction to the concrete form of solid fact; and having now reached a stage in the history of this gas which enables one to speak with something like confidence as to the part which acetylene is likely to play in the future, it needs no further excuse for again choosing it as a subject of interest to The Gas Institute.

It is almost unnecessary for me to remind you that the commercial possibility of using acetylene is dependent on the discovery made by Willson in America, and later, but independently, by Moissan in France, of the fact that at the temperature of the electric arc it is possible to fuse together lime and carbon, and that under these conditions some of the carbon reduces the lime to metallic calcium by combining with its oxygen to form the gas carbon monoxide, which escapes, while the calcium combines with the remaining carbon to form the heavy semi-metallic looking mass calcic carbide, which in turn generates acetylene when brought in contact with water. When 1·8 tons of a mixture of 100 parts of pure lime and 68 parts of powdered oven-coke of low ash are fused together in the electric furnace, 1 ton of calcic carbide is produced; while each electrical horse power per hour used in the furnace will yield from 0·3 lb. to 0·5 lb. of calcic carbide. A considerable amount of carbide is lost during crushing and packing; and in practical working it is found that 1 electrical horse power per annum will yield from 1¼ to 1½ tons of packed carbide. These figures dispose of the ridiculous prices quoted in the days before experience tempered theory; and it is now only the inventor or company promoter who ever allows his mind and tongue to run riot with carbide at £2 or £3 a ton.

The forms of electric furnace used for making carbide do not vary very greatly. The current must be made to pass between two poles; and whether these be vertical or horizontal, or whether one be a plate or the body of the furnace itself, does not appear to make any very radical difference. The most economical forms are the modifications of the Willson furnace used at Niagara, St. Catherine's in Canada, and at Foyers in Scotland; and in this class of furnace the heat of the arc is kept in by the surrounding mixture of lime and carbon, so that very little waste of heat takes place. In the furnaces used at Froges, on the other hand, the one terminal is a carbon crucible or chamber, into which the other pole is lowered; the result being that the carbide is so liquid that it can be run from the furnace. But the wear and tear would make this too costly to be generally carried out. Other forms—such as the "Bullier" furnace used at Notre Dame de Briançon, and those used at Neuhausen and Bitterfeld—differ but little from the first class, so that the cost of production is more dependent upon the cost of the electrical energy used than upon anything else; and as waste power is not too plentiful in Great Britain, it is manifest that the cost of carbide will always be rather high.

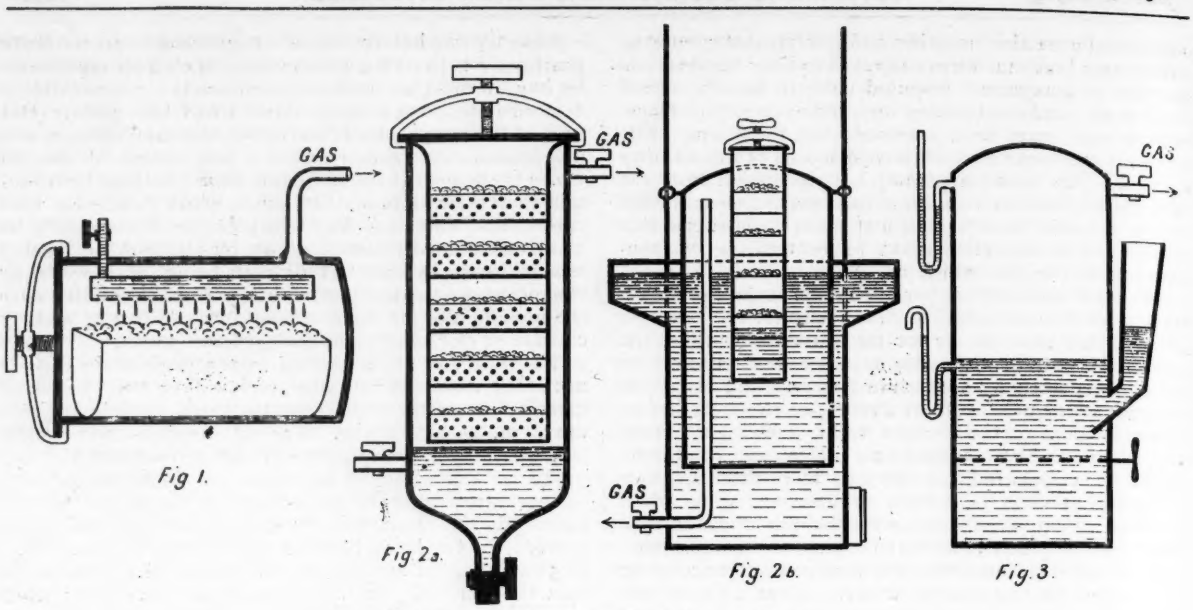
In practically considering the price of carbide and the cost of acetylene, it is useless to take into account any other factor than the price at which carbide can be bought in bulk; and this is £16 a ton at the carbide works, which probably means £20 delivered in most localities. It is reported that Dr. Borchers, of Aix-la-Chapelle, and others have succeeded in making calcic carbide without electricity; and hopes run high that this may bring about a revolution in the carbide market. But there are many considerations which lead to the belief that, even if this feat has been accomplished, its practical value will be little. Given water gas and regenerative settings, an enormously high temperature can be attained; but the material of which to build a crucible or furnace that will stand it has yet to be discovered, while at this temperature no signs of direct combination are to be detected.

In using the electric furnace, the intense heat of the electric arc is generated in the centre of the mass to be fused by it; and so the wear and tear to the furnace is avoided. But this would be practically impossible, even if the requisite temperature could be reached, by a combustion process; and the result would be that electrical heating would probably be less expensive than the other. It is perfectly well known that, if a temperature commercially practicable is to be used, some metal with a strong affinity for oxygen must be employed to reduce the lime to calcium before combination with the carbon will take place. But such of the metals as will do this—potassium, sodium, and magnesium—are costly; and if a process were devised in which the vapours of such metals were liberated by reduction from their salts, and were then made to interact with carbon and lime at a high temperature, it could only be made commercially possible either by a large demand being created for the bye-product, or by its being capable of being cheaply worked up and used over again, while in either case the probabilities are the cost would exceed that of making carbide by electricity generated by water power.

The prospects of a reduction in the price of the carbide not being therefore very hopeful, it will be well to base all calculations of the price of acetylene on carbide at £16 a ton at the carbide works. The carbide sold commercially is a mixture of nearly pure crystalline material, yielding 5·5 to 5·8 cubic feet of acetylene per pound at ordinary temperatures, with the crust which in the electric furnace surrounds the ingot, and which has a lower gas-generating power; the two being blended together to yield an average of 5 cubic feet of gas per pound of carbide. This means that the ton will generate 11,200 cubic feet of gas; while as a residue there is produced 1·15 tons of slaked lime, the value of which for purification may be taken as paying for water, the small amount of labour needed in feeding the carbide into the generator, and charge on plant. Thus the cost of the acetylene in the holder is practically 30s. to 40s. per 1000 cubic feet, according to the cost of carriage of the carbide.

The illuminating value of the gas when burnt under the best conditions for developing its marvellous light-giving powers is 240 candles per 5 cubic feet. But these conditions cannot be fulfilled in practice; and when burnt in the 1-foot burners best adapted for its use, the illuminating power actually obtained is at best only 35 candles, which makes it for ordinary use a 175-candle gas. So that as far as illuminating value goes, it is about eleven times the value of coal gas. But as it costs about thirty times as much as London coal gas in the holder, the dread of it as a rival for town supply need not at present strike terror into the gas manager's breast. Moreover, the 35 candles per foot obtained in a 1-foot burner is only twice the value obtained from a foot of ordinary coal gas by means of the incandescent mantle. It is thus at once seen that no rivalry can exist between the two where the consumption is on a large scale. As, however, the quantity of gas to be made grows smaller, the cost of making it increases at an enormous ratio; so that while the South Metropolitan Company can make gas at 1s. 2d. per 1000 cubic feet in the holder, and show a handsome profit by distributing and selling it at 2s. 6d. per 1000 cubic feet, there are many villages and small towns where, owing to their straggling nature and small consumption, coal gas could not be sold profitably at 10s. per 1000 cubic feet. It is in such places, and in country houses, railway stations, and large institutions, that acetylene is at present making considerable headway—not as a competitor with coal gas, but rather as a rival of the electric light and oil-lamp. This field of utility is, however, somewhat restricted; and as company after company is formed to exploit some form or other of generator, those who are best able to judge cannot but see that the field of operation is so limited for undiluted acetylene, and the number of forms of generator so large, that at best only a very moderate return on the capital invested can be expected.

The use of acetylene in the condition in which it is produced from most generators is fraught with certain difficulties, which are dependent partly on the form of apparatus used, partly on the methods employed in consuming the gas, and to a small extent on the purity of the carbide itself. The chemical and physical properties of calcic carbide have been so often described of late, that the briefest recapitulation will suffice to bring them to mind. It is a semi-metallic solid which when pure has a crystalline fracture and a play of various colours over a newly broken surface. This, however, soon gives way to a whitish coating of lime formed by contact with the moisture always present in the air. It has a specific gravity of 2·2, and is so hard that considerable difficulty is found in breaking it down for use in generators requiring a special size. Slight impurities present in the lime and coke give rise to



TYPES OF ACETYLENE GAS GENERATORS.

small quantities of foreign compounds in the calcic carbide. Chief among these bodies are carborundum, the carbide of silicon generally found in black flakes or crust in the calcic carbide, silicides of iron and magnesium forming metallic looking nodules occasionally found in the true carbide, metallic iron, and sometimes calcium, nitride of magnesium, compounds of sulphur and phosphorus with other bodies, and unchanged lime and carbon. Of all these, the ones which exercise the most important influence on the acetylene are compounds containing sulphur and phosphorus, which yield during the decomposition of the carbide the sulphuretted and phosphuretted hydrogen usually found as impurities in the gas, and some form of silicide which under the same conditions yields siliciuretted hydrogen. The nitride of magnesium which is formed by molten magnesium in the ingot taking up nitrogen from the air is also an important impurity, as it is supposed to be responsible for the ammonia nearly always present in the gas, and which favours the action of the acetylene on metals.

It has been suspected that the phosphuretted and siliciuretted hydrogen present in the acetylene as impurities might make it spontaneously inflammable, and so give rise to danger. But very careful experiments show that with English carbide this fear is unfounded—great care being taken to ensure the purity of the lime and coke used in its manufacture; and though carbide of Continental make is far more impure, the result is more fouling of the atmosphere by the products of combustion than danger from spontaneous ignition. Even if the smallest quantities of phosphuretted and siliciuretted hydrogen be present in the gas, the phosphorus pentoxide and silica formed on combustion will give a haze in the air, and affect delicate chests most disagreeably. Indeed, at the recent Acetylene Exhibition held at Berlin, the leading German gas journal reports that the haze of impurities was so bad that no one with a weak chest could remain in it; while at the Acetylene Exhibition now being held at the Imperial Institute, and which will remain open for two or three months, no indication of any such trouble has shown itself, though several hundred burners are going.

The purity of the acetylene depends a good deal upon the way in which it is generated; and though at first sight it seems a matter of little importance as to how the contact between the water and the carbide is brought about, in practice much depends upon it. From a scientific point of view, there are two sets of conditions under which the decomposition may be taking place—

1.—Such conditions that during the greater part of the action there is an excess of carbide.

2.—Conditions such that the water is always present in excess.

And the generators may be divided into three main classes—

1.—Those in which water is allowed to flow or drip on to calcic carbide; the evolution of the gas being regulated by controlling the flow of water.

2.—Those in which water in bulk is brought in contact with the carbide; the evolution being regulated by again separating the carbide and water.

This group is again subdivided into two—

(*a*) Those in which the carbide cage or carrier is attached to the bell of the acetylene holder, so that when the evolution of the gas exceeds the consumption the bell rises and removes the carbide from the water.

(*b*) Those in which the water rises from below into the generator, and comes in contact with the carbide; over-generation causing an increase of pressure in the generator which drives the water back.

3.—Those forms of generator in which the carbide drops into an excess of water, and a holder of sufficient capacity is provided to receive all the gas made.

The great desideratum to be satisfied by a good acetylene generator is that no excessive heating should take place in the generating chamber, as acetylene is a compound which under the influence of heat polymerizes—*i.e.*, combines several molecules into one forming such bodies as benzene and styrolene; while at still higher temperatures anthracene, tar, and even naphthalene are formed—and under these conditions not only is the yield of acetylene very much reduced, but other gases are formed which dilute it and reduce its illuminating value. In a paper contributed to the Society of Chemical Industry early this month, all these points were fully dealt with, and experimental evidence given on which the following conclusions are based.

The generators of the third class are undoubtedly the best, as with the water kept in excess and changed at the rate of 8 pints per hour for each pound of carbide decomposed, it is impossible for the temperature to rise above the boiling point of water. To ensure this, however, there must be a false bottom to the generator, capable of being occasionally rocked, about 12 to 18 inches above the true bottom; the lime sludge being drawn off from the bottom and water admitted *pro ratâ* from above. If there is no false bottom, and a big charge of carbide is introduced, it becomes so coated with lime that the melting point of tin may be reached in the interior of the mass; but under all conditions this class of generator yields the purest gas, as the acetylene having to bubble through the lime water formed in the generator is washed free from most of its impurities.

The generators of the first class, in which water is allowed to drip or flow on to the carbide, have several drawbacks. A popular fallacy with the makers of automatic generators of this character is that when the water supply is cut off the generation of gas ceases; whereas in fact it continues an hour or so longer, though the rate at which it is evolved gradually gets slower and slower until it ultimately ceases. This continuation of generation is partly due to condensation of water vapour on to the undecomposed carbide as the generator cools, and to the decomposition of water

mechanically held by the slaked lime; while if the temperature be very high the slaked lime is itself dehydrated. In this class of generator the temperature frequently rises to a sufficient degree to cause the formation of benzene; while in some cases tar is produced. Over-heating when it reaches this point is readily detected by the appearance of the lime left in the generator. This should be practically white; but if it is found to be yellow, serious overheating has undoubtedly taken place, while the appearance of oil or tar in any part of the apparatus is a still more damning proof of its unfitness.

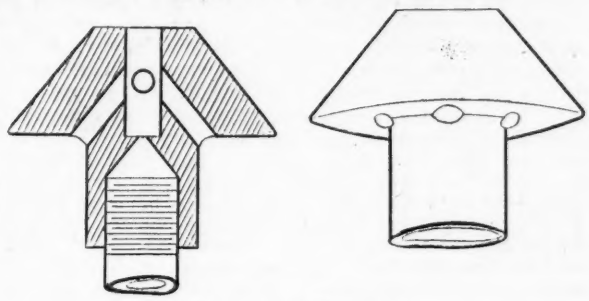
The worst offenders as regards overheating are to be found in the first division of the second group, where the alternate dipping of the carbide into water, and its removal as the bell rises, allows the action to proceed without any cooling influence being brought to bear upon it. It frequently happens that under these conditions the whole charge of carbide becomes red hot, tar vapours, hydrogen, various hydrocarbons, and benzene vapours are mixed with the acetylene, and its illuminating value drops by leaps and bounds until its light-giving properties are no better than those of a good oil gas; while the burner-tips become choked and smoking, and general discontent reigns supreme. There are several generators in the second division of the second class which, though not so good as those of the third class, yet do their work satisfactorily and do not give rise to much trouble from overheating, as the water is only allowed to rise so slowly in contact with the carbide that over-generation is avoided; while there being ample holder room for all the acetylene it is possible to obtain from the charge of carbide used, there is but little fear of the water being driven back.

In the exhibition at the Imperial Institute, there are between twenty and thirty of the best generators in the market in constant use; and it will be found that practically none of these shows serious overheating. But it must be borne in mind that the great danger of overheating arises when the generator is overdriven. Makers do not recognize the stupidity of assuring a purchaser that their 10-light generator will quite well supply a 14-light installation, while in all probability it is only fitted for 5 lights. Their desire is to sell a generator; and in this they succeed. But the trouble which arises when the generator is overpressed not only discredits them, but gains a bad name for the gas.

One of the greatest troubles in the introduction of acetylene has been to find a burner suitable for its consumption. All the burners first introduced proved failures, as they developed a tendency to smoke after from 60 to 200 hours' burning. The trouble generally commenced by a filiform growth of carbon appearing at the nipple, which quickly distorted the flame and caused a cloud of soot flakes to descend. If the burner was cleaned and relighted, the trouble commenced again in an hour or two; and the only thing to be done was to replace the nipple by a new one. If the nipple had been burning some time, and the steatite was removed and broken, it was found to be carbonized for some depth into the material—showing that a liquid hydrocarbon had soaked into the material, and had been split up there by the heat, with deposition of carbon. The generally accepted idea was that the heat of the nipple polymerized some of the acetylene to benzene, and that this forming a drop did the mischief; and efforts to keep the burner cool were looked upon as a likely direction in which to search for success.

At this juncture, the Naphey or Dolan burner was introduced in America; the principle employed being to use two small and widely separated jets instead of the two openings of the union-jet burner, and to make each jet a minute bunsen, in which each jet of acetylene dragged in from the base of the nipple enough air to surround and protect it while burning from any contact with the steatite. These burners were hailed with delight; and their success led to their being pirated right and left—many laughable forms being adopted in the efforts to avoid the original patent. But though the burners mark a very great improvement, and will burn for several hundred hours without smoking—unless, in a fit of false economy, the user insists on turning them down and leaving them for an hour or so as two small separate flames, in which case they generally at once start smoking on being again turned on—the trouble is by no means got over; and a Naphey burner will often be found smoking as heartily as one of its more humble brethren.

The fact is that the cause of smoking is to be found quite as much in the generator as in the nipple; and overheating during generation is undoubtedly a prime factor in this worrying phenomenon. Overheating, as before pointed out, forms benzene, which is carried as a vapour by the gas, and remains in suspension until the friction of the gas through the minute holes in the nipple scrubs it out, and causes its deposition. Moreover, when the holes in a union-jet burner have been arranged for the consumption of acetylene, the presence of benzene at once causes it to smoke, as the benzene requires three times as much air for its consumption when in the form of a vapour as an equal volume of acetylene does; and the result is that the balance of the burner is entirely upset. Purification of the acetylene by properly devised scrubbers would lessen the evil to a great extent; and within the last few days a burner has been brought out in which a regulating and purifying box below the nipple is claimed to make it possible to use a No. ooooo Bray tip for a long period.



Acetylene Burner.

A great deal more is known now as to the dangers of acetylene than when the Institute last discussed the question; and it is recognized as being no more poisonous than ordinary coal gas, and under all ordinary pressures hardly more dangerous, except that mixtures of acetylene and air are explosive over a wider range than is the case with coal gas and air. For instance, it takes 5 to 6 per cent. of coal gas to be present in air before it shows any explosive tendency; while with acetylene gas, according to Dr. Clowes, 3 per cent. is sufficient. The chief danger, however, lies in the possibility of detonating acetylene—that is to say, that when pure acetylene is subjected to a sudden heat sufficiently intense to cause it to break up into its constituents, it will do so under certain conditions with extreme violence; while exploding a detonator of mercuric fulminate in the gas produces the same effect. The explosion, however, only spreads in the gas if it be under a pressure of more than 2 atmospheres—that is to say, that if a mercuric fulminate cap be fired in acetylene at anything under atmospheric pressure, the only result is the splitting up of the acetylene in the immediate neighbourhood of the cap into carbon and hydrogen; while if the pressure exceeds 2 atmospheres, the whole volume of the gas is instantaneously decomposed into its constituents, with great explosive force. The same phenomena are observed when the gas is heated at any one point to its decomposing temperature. Liquid acetylene is liable to decomposition in the same way; and several disastrous accidents having happened abroad, the Home Office recently issued a notification forbidding the use of the liquefied gas, and limiting the pressure at which the gas might be used to 100 inches.

This at once dealt a serious blow to what had been looked forward to as the most remunerative field in which acetylene could be used—viz., the utilization of the gas compressed into railway cylinders for carriage lighting. In Germany, the great firm of Julius Pintsch have long been experimenting with mixtures of oil gas and acetylene, most of the State Railways being now lighted by it; and under these conditions, application was made to the Home Office to sanction the use of such mixtures under the ordinary railway carriage cylinder pressure of 10 atmospheres. After an exhaustive series of tests made before the Home Office officials, it was clearly demonstrated that such a mixture—or, indeed, mixtures considerably richer in acetylene—were as safe as oil gas alone; and by an order of the Secretary of State, dated March 28, 1898, oil gas containing 20 per cent. of acetylene is allowed to be used at a pressure not exceeding 150 lbs. on the square inch. The following experiments were made, in order to ascertain to what extent

the addition of acetylene increased the illuminating value of the gas for railway-carriage lighting, and whether the use of such a mixture is economically possible.

A holder full of ordinary oil gas having been made, one-half was run into a second holder and enriched with 20 per cent. of acetylene; the mixture being then pumped into a railway cylinder under a pressure of 10 atmospheres. The remaining oil gas was pumped into a second cylinder of the same size and to the same pressure, and both cylinders were blown off to a pressure of 5·8 atmospheres; the contents of each being tested under precisely similar conditions. The burner used in each case was a "40-litre" one; and the results were as follows:—

Pressure.	Gas Consumption.	Illuminating Value. Oil Gas.	Oil Gas with Acetylene.
5·8 atmos.	1 cubic foot.	7·4 candles.	15·6 candles.

The mixture was made to contain as nearly 20 per cent. of acetylene as possible; but on pumping oil gas to a pressure of 10 atmospheres, there is always a certain amount of condensation of the vapours of benzene and toluene to the liquid state, which might cause variation in the percentage of acetylene present. Analysis of the gas showed it to contain 22 per cent., which had given an increase in luminosity of 110 per cent., or 100 per cent. increase for 20 per cent. The compressed gas, however, was required for the specific purpose of railway-carriage lighting; and the oil gas and mixture were next compared in actual railway-carriage lamps for their lighting power at angles below the horizontal; the Dibdin radial photometer being used for the comparison, and the gas being burnt at a uniform pressure of 1 inch.

Oil Gas.

Angle.	Gas Burnt.	Candles.	Candles per Cubic Foot.
Horizontal	2 cub. ft.	7·4	3·70
10 deg.	"	8·0	4·00
20 "	"	8·2	4·10
30 "	"	8·2	4·10
40 "	"	8·2	4·10
50 "	"	8·0	4·00
60 "	"	7·6	3·80
70 "	"	7·8	3·90
80 "	"	8·0	4·00

Average candles per cubic foot, 3·9.

Oil Gas and Acetylene.

Horizontal	2 cub. ft.	17·0	8·50
10 deg.	"	17·0	8·50
20 "	"	17·5	8·75
30 "	"	18·0	9·00
40 "	"	17·0	8·50
50 "	"	17·0	8·50
60 "	"	17·0	8·50
70 "	"	16·5	8·25
80 "	"	16·5	8·25

Average candles per cubic foot, 8·5.

This shows that the addition of 22 per cent. of acetylene to the oil gas gives an increase of over 110 per cent. in its illuminating value, when measured at all angles. It is evident, therefore, that it may be said that the addition of 20 per cent. of acetylene to oil gas of the ordinary quality employed for railway-carriage lighting doubles its illuminating value.

Taking the price of carbide at £16 a ton at the works and £20 delivered, the acetylene will cost £1 18s. per 1000 cubic feet in the holder; and 200 cubic feet will cost 7s. 6d. The compressed oil gas costs 6s. to 12s. per 1000 cubic feet, according to locality. If the oil gas be taken at 8s. per 1000 cubic feet, then 800 cubic feet will cost 6s. 5d.; while the 200 cubic feet of acetylene will cost 7s. 8d. The cost of 1000 cubic feet of the mixture thus amounts to 14s. 1d., as against 8s.; but as it is of double the illuminating value, there is an economy of 1s. 11d. per 1000 cubic feet. The saving, of course, increases as local circumstances make the oil gas dearer, and diminishes as it is cheaper, until with oil gas at 6s. 6d. per 1000 cubic feet there is practically no difference. There are, however, several other advantages which, even in such cases, would make the use of such a mixture desirable—

1.—The light-giving value of the gas being double, the cylinders at present in use would go without charging for twice the usual period—a gain which cannot be over-rated.

2.—With oil gas alone liquid hydrocarbons are condensed in the cylinders during compression, and revaporizing when the pressure becomes low cause serious variations in the illuminating power, and tend to cause smoking.

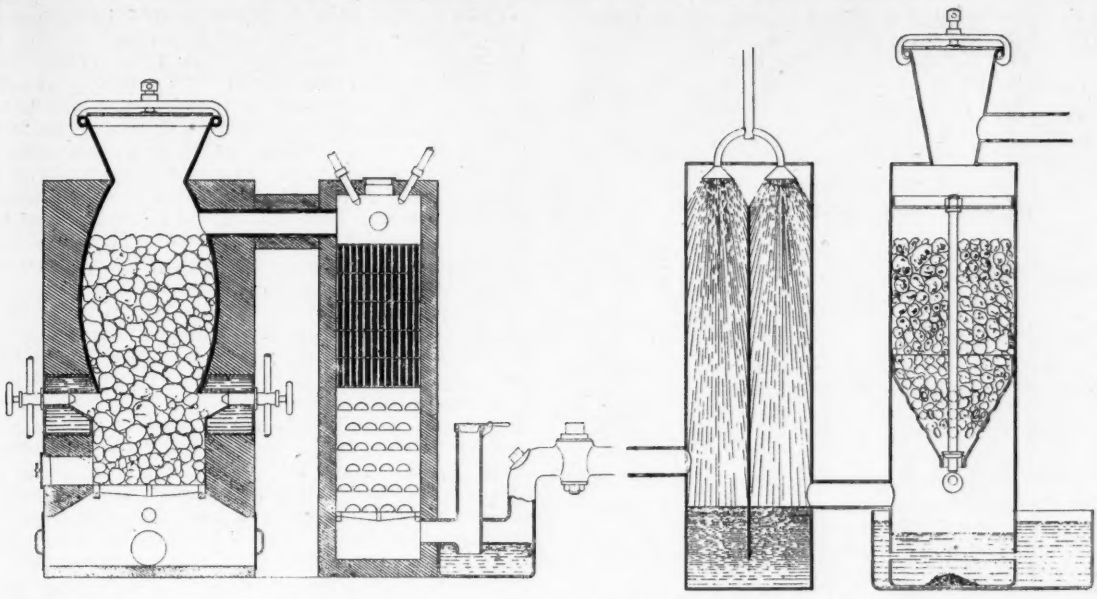
No such condensation takes place with pure acetylene at such pressures; and the presence of 20 per cent. of this gas reduces the trouble and tends to equalize the illuminating power. It is clear, therefore, that the utilization of such mixtures of oil gas and acetylene for railway carriage, buoy, and tramcar lighting will mark an important advance. It must, however, be borne in mind that there are other spheres of usefulness for acetylene than those enumerated; and among these I should say that the distribution of dilute acetylene in large villages or small towns in which a coal-gas installation does not at present exist, offers certainly one of the most extended fields. For this purpose oil gas would be far too costly, and require too bulky and expensive a plant to give much advantage over coal gas.

The brilliancy and beauty of the light emitted by acetylene when burnt alone has had a great deal to do with the enormous amount of interest which has centred about this new illuminant since the discovery of the cheap production of carbide made it a commercial possibility; but there have been drawbacks which have militated to a certain extent against its success. The fact of a very high illuminating value being emitted from a comparatively small source gives a severe strain to the eyes, unless the source of light be most carefully shielded from it; while the same factor tends to dark, hard shadows, so that the illuminating effect is not nearly so good as the illuminating value registered on the photometer would lead one to expect. This trouble, as well as that of smoky burners, disappears when dilute acetylene is used.

The whole question seemed to be of such importance, and the whole future of acetylene so to hinge upon the being able to secure a cheap diluent for the gas which would at the same time keep up its illuminating value in enrichment, and which would reduce or do away with all risk of explosion when under pressure, that much time was devoted to a thorough investigation of the subject, and the causes which lead to the loss of illuminating power when such gases as hydrogen and carbon monoxide are used for diluting it. Processes have been devised for diluting the gas with air; but the wide range over which such mixtures are explosive renders this far too dangerous for ordinary practice, while when water gas, hydrogen, or carbon monoxide are used, a very large percentage of acetylene is required before any luminosity is produced, and such diluent can only be economically employed if the acetylene and the diluting gas be mixed in about equal proportions. It has further been proposed to dilute acetylene with nitrogen, and claimed that this has not such an injurious action upon the illuminating value of the acetylene as the before-mentioned gases. In order to obtain pure nitrogen from the atmosphere, however, the oxygen has to be removed; and any ordinary process for doing this renders it too costly to be employed for such purpose. Nevertheless, it is obvious that in many places it would be of great advantage to have an illuminating gas of about 20-candle power for general distribution, in the same way that a good coal gas is used, if such a mixture could be produced at a price comparing at all advantageously with that of coal gas. Experiment showed that, in all these cases, until the acetylene has reached a very high percentage as compared with the diluting gas, it utterly fails to develop the illuminating power which one would have expected from it, and that in small percentages the illuminating power is entirely destroyed; while if the full theoretical enriching value had been developed, it ought to have given 2·4 candles for each per cent. added to a non-luminous gas, whereas in no case was this value reached.

Some years ago a considerable amount of work was carried out by the author on the part played by the various gases in a coal-gas flame; and he was then very much struck with the importance of methane, not only in increasing the size of the flame, but also in keeping up the illuminating power. It occurred to him that it would be worth while trying the effect of methane as a diluent for acetylene. This at once proved to be of the greatest value, as mixtures of methane and acetylene gave a higher illuminating value than 2·4 candles for each per cent. added. Indeed, with a mixture of methane and 10 per cent. of acetylene, the enrichment value of the acetylene came out at over 3 candles for each per cent. added; and a further series of experiments soon showed that the addition of methane to any of the previously tried diluents at once caused a most remarkable alteration in the enrichment value of the acetylene so added.

The importance of this discovery was at once seen to be very great, as though it would be impossible to use pure



A Methane, Hydrogen, and Water-Gas Generator.

methane as the diluent for acetylene, on account of the cost of its production, it is quite easy to make a diluting gas which shall contain 30 per cent. of methane at a comparatively low rate. In order to make this, a slightly modified form of water-gas generator is employed; and the fuel having been blown up to incandescence by an air-blast, tar, creosote oil, heavy oil residues, or practically any waste liquid hydrocarbon is injected into the body of the incandescent fuel by a steam injector or atomizer. If these hydrocarbons were all allowed to run into the fuel by themselves, they would simply be burnt up to carbon and hydrogen; but being steam-injected, the steam is decomposed by the fuel, with the formation of water gas, which to a certain extent envelops the hydrocarbon, and instead of its undergoing complete decomposition it is broken down to methane and hydrogen, and mingles with the water gas, while any residual carbon is left behind in the fuel. It is quite possible, by such means as this, to make a diluting gas containing—

Hydrogen	45 per cent.
Carbon monoxide	15 ,,
Methane	30 ,,
Unsaturated hydrocarbons	5 ,,
Carbon dioxide and nitrogen	5 ,,
	100

The gas costs from 8d. to 10d. per 1000 cubic feet, and has an initial illuminating value of about 10 to 12 candles. On mixing with it 5 per cent. of acetylene, a gas having an illuminating value of 18 to 20 candles is obtained, which being a mixture of perfect gases gives no trouble as regards layering, and which having the same specific gravity and illuminating value as coal gas can be distributed and burnt in precisely the same way. It is also found that mixtures of this gas with 50 per cent. of acetylene are not detonated when compressed for railway-carriage lighting by any temperature which it would be possible to attain in the cylinder; and it seems that this method of utilizing acetylene is pre-eminently the one which promises for it the largest and most remunerative future.

Having completed the task of bringing the subject of acetylene up to date, a dive into the future may be permitted. It is not at all impossible that in days to come acetylene may play an important part in that ideal condition of things which will only be reached when the whole of the residues are worked up in the gas-works and the whole of the coal used is converted into gaseous matter. Imagine the red-hot coke from the inclined retorts being shot straight into cupolas, where, by processes somewhat akin to the "Dellwik," each ton is made to yield over 70,000 cubic feet of water gas, which, utilized to drive gas-motors, gives electrical power at one-fourth the price of steam power. This can be at once used in electrical furnaces for the production of cheap carbide; and the acetylene produced from this and diluted with gas made from coke and tar, can be delivered into the holder to enrich not only the quality, but also the quantity of the gas supply.

Mr. W. A. Valon (Ramsgate), in proposing a vote of thanks to Professor Lewes, said the members all knew his labours, and the success which had attended them. The Institute was much indebted to him for the able lectures he had given from time to time at the annual meetings; the present being by no means the least interesting. Many of the fallacies which surrounded the subject of acetylene gas had been dispelled; and, speaking for himself, its true position had never before been so clearly set forth. They all regarded Professor Lewes with warmer feelings than those of mere admiration for him as a man of science—indeed, they looked upon him as a brother; and there was no need for any further words to commend this resolution to their acceptance.

Mr. D. Irving (Bristol) seconded the motion. He said they had had a brilliant and masterly simple lecture, to which it was quite a privilege to listen. It was always well, in dealing with a competitor or rival, not to underestimate it; and although he had been very glad to hear some of the assurances Professor Lewes had given them that morning, he could not forget that, in the West of England, he was informed that in a neighbouring town to his own acetylene was a real competitor with gas—the pier, an extensive building, and several large establishments being lighted by acetylene gas. He did not feel alarmed at it; but, on the other hand, those interested in the gas industry would do well not to under-estimate their competitors—whether electricity, acetylene, or oil lighting—but to seek in every possible way to produce the best and cheapest gas. This was the only security they had any right to expect for their own industry.

Dr. Stevenson Macadam, in supporting the motion, said it was a great satisfaction to have had Professor Lewes coming forward with so practical a history of acetylene, and to some extent a forecast of its future. He (Dr. Macadam) did not regard acetylene as a rival of coal gas; but there were circumstances in which it might be employed as an enriching gas for railway carriages, where there must be a certain amount of light stored up in a limited space. He also recognized the possibility of its being employed for other purposes, such as the lighting of small villages; and there might be a future for it in large gas-works, where it might be utilized as an enricher. The great point was that they should welcome all possible illuminants, and make the best use of them, not regarding them as rivals, but as aids in developing illumination. Personally, he felt much indebted to Professor Lewes; and, as an experimentalist himself, he could only speak with admiration of the remarkable success which had attended the experiments shown, which were complicated, and depended on many circumstances which were not obvious when they were carried out.

The vote of thanks having been carried by acclamation,

Professor Lewes, in responding, said it was always a pleasure to lecture before The Gas Institute. He did not feel seriously alarmed about the rivalry that had been

spoken of on the pier and at several leading establishments in a town which had been referred to. In these days of advertising, everything was snapped up which could be used as a novelty; but whether, when the novelty which led ladies to look in a draper's window had worn off, he would still continue to pay eleven times the ordinary price for his illumination, was another question altogether.

PAPERS AND DISCUSSIONS.

THE VALUATION OF GAS-WORKS FOR ASSESSMENT.

By William Newbigging, of Manchester.

The subject of gas-works rating is one that has seldom been dealt with at the meetings of the Institute. Since Mr. William Carr's valuable contribution in 1885 we look through the "Transactions" in vain for any paper or discussion on the question. This is not due to lack of interest, but arises to a certain extent from the fact that the circumstances of gas undertakings, as regards their invested capital, the character of the districts and their population, and the prices obtained for gas, vary so much that it has baffled the keenest minds to devise or suggest a method of assessment that would bear equally and fairly on all gas undertakings, no matter how different the circumstances of each.

The present method is admittedly faulty; and it is repeatedly asked whether combined action on the part of owners of gas-works would not result in obtaining decisions on certain points, and so lessen the difficulty of fixing a rateable value that would be satisfactory to all parties. We have, however, repeatedly seen the wealthiest gas undertakings of the Metropolis, with all resources at command, grapple with the question of their assessments; and the end of a long and costly appeal case has usually found them in practically the same position as at the beginning of the appeal—viz., with a rateable value unsatisfactory to both parties. As it is seldom stated which of the items most in dispute have been allowed or struck out, the matter is left in doubt, to be fought over again at the next quinquennial valuation. Perhaps too much stress is laid on the absence of definite decisions on certain points, because, as a matter of fact, if it were agreed by opposing parties that certain items were to be allowed and others abandoned, while such an arrangement might be satisfactory in one instance, to attempt to carry it out in another would result in grossly unfair or absurd results, as the case might be. Anyone familiar with rating methods knows that, by a little manipulation of certain items, it is possible to get results as wide apart as the Poles—and that without going beyond legal limits, or even the limits of one's own conscience, if only it is sufficiently elastic. The items which vitally affect the result are well known. They are fought over and argued to-day as they were half a century ago, and are no nearer a settlement. However unsatisfactory this may be, there is little probability that the law will be altered; and it is well, therefore, that we should be familiar with the points which, under the present system, affect so greatly the rateable value.

Before dealing with these, there is one matter I wish to bring forward, and that is with regard to the method—now very common—of comparing the assessments on different gas undertakings by means of a table showing, in one column the selling price of gas, and in another column the amount paid per 1000 cubic feet on account of rates and taxes. There is a fallacy underlying this method of comparison which is apt to mislead. It does not follow that, because A is paying 2·6d. per 1000 cubic feet, he is unfairly rated as compared with B, who is only paying 1·6d. It often happens that the undertaking paying the smaller amount is in reality more heavily rated than the one paying the larger amount. Another column should be inserted, if this method of comparison is adopted, showing the percentage that the amount paid per 1000 cubic feet bears to the selling price of gas. The following table clearly illustrates this; the figures being taken from recent cases:—

	Selling Price per 1000 Cubic Ft.	Amount Paid per 1000 Cubic Ft.	Percentage on the Selling Price.
A	3s. 2d.	3·0d.	7·90
B	1 10	2·0d.	9·00
C	3 10	2·6d.	5·65
D	2 0	1·9d.	7·90
E	3 0	2·5d.	7·00

It will be seen that A, paying 3d. per 1000 cubic feet, is only paying 7·9 per cent., while B, with 2d., is paying 9 per cent. of the amount which he receives for the gas. This is important, and should be borne in mind when comparing tables compiled on these lines. It is not to be inferred from these remarks that I suggest that the amount to be paid per 1000 cubic feet on account of rates and taxes should move *pro ratâ* to the selling price. The point I wish to make clear is that the method of comparison is misleading—as, indeed, are all methods of comparing the assessments of gas undertakings. There are no two undertakings similarly situated; and trustworthy comparisons are almost impossible.

Coming more closely to the purpose of my paper, the principal items which are the cause of so many differences are under the head of "tenant's capital," or they are items which have a great bearing on the tenant's capital. First, therefore, let us deal with the hypothetical tenant himself. In spite of the anathemas which have been hurled at his head, the hypothetical tenant is not a bad sort of fellow. Could he but speak, I am sure he would say something to this effect: "I am willing to help you all I can to solve this problem; but you"—referring to the owners and the Assessment Committee—"must exercise a little sweet reasonableness." This is our first difficulty. Assessment Committees are given to looking on the hypothetical tenant as a very shady character. They will not give him credit for even ordinary business habits. They assume that he would be shamefully backward in the matter of paying his bills, whether for raw materials, for rates, or any other payment that he would have to make. On the other hand, they assume that he would be most assiduous in the collection of accounts due to him, and that he would obtain payment for his residual products within a few days of their being made. It is no doubt very convenient to assume that the hypothetical tenant would be all that is bad; but is it fair to the gas undertaking, or is it acting up to either the letter or the spirit of the Parochial Assessment Act? Surely when the framers of that measure laid it down that, in order to ascertain the rateable, we must assume a hypothetical tenant, they meant also that we must assume him to be an honest man, who would conduct the undertaking on everyday business principles. Let us, for instance, take the first item on which a difference of opinion usually arises, and that is with regard to the treatment of the residual products.

Should the Amount Received for Residuals be put under the Head of Receipts, or Should it be Deducted from the Cost of the Coal on the Expenditure Side of the Account?—This question is one on which the facts are ascertainable; and so it should not, except under special circumstances, be a cause for disputes or differences. And yet, without any inquiries as to how payment is made for coal or received for residuals, I have known the amount to be placed indiscriminately under receipts or deducted from the cost of the coal. In the great majority of cases, the deduction of the amount received for residuals from the cost of the coal cannot be justified. The net receipts are not affected whichever head it is put under; but if it is deducted from the cost of the coal the tenant is the sufferer, inasmuch as it reduces the amount of the working capital on which he is entitled to interest. If the revenue from residuals comes in before the coal has to be paid for, it should be deducted from the cost of the coal; but, as a matter of fact, coal is paid for within a month of delivery. On the other hand, we find, in the case of ammoniacal liquor, that the liquor has first to be made, and then worked up to sufficient strength, before it is sent away or converted into sulphate of ammonia. In the latter case particularly, many months sometimes elapse before payment is received. Tar, again, is made and stored until there is sufficient to despatch. Coke is sold in small quantities for cash, or in large quantities for monthly payments, it is true, though it is often accumulated for months before it is cleared out of the yard; and three months' credit is frequently given. But whatever the facts, they can be ascertained, and the item put under its proper heading.

The foregoing item is the only one under the head of "*receipts*" over which there is likely to be great disagreement. Under the head of "*expenditure*," any items which are abnormally large or small, as the case may be, are averaged over a few years. There is one item—that of *rates and taxes*—which should be mentioned. Instead

of putting the amount under expenditure, it is often deducted at the end of the valuation. This is not fair to the tenant. Rates and taxes are yearly or half-yearly payments, due in advance and on demand; and though this is not always strictly enforced, it is the usual custom to pay the amount within a few weeks of the date of the receipt of notice to pay. As with the item for residual products, the facts are ascertainable; and if this item for rates and taxes is not included under expenditure, the tenant again loses the interest allowed on such portion of his working capital.

We now come to the *tenant's capital*, almost every item of which is a bone of contention.

Working Expenses.—A tenant, on taking over a concern, would have to provide sufficient capital to tide him over the period during which his revenue is accruing. The time claimed varies from four to five months. The expenditure is therefore divided into twelve equal parts; and four to five of these parts gives the amount which the tenant would require by way of working expenses. A portion of the total amount of repairs, as shown in the accounts, is spent on the tenant's chattels, and fairly comes under the head of expenditure. Repairs and maintenance of the hereditament are landlord's duties, and come under the head of statutable deductions. The daily repairs to the hereditament would, in actual practice, be paid for by the tenant, even though the landlord reimbursed him at the end of the quarter; and the amount should be brought under working expenses, and interest allowed on same. Exception is taken to adding the cost of repairs in this way to the working expenses; and it is pointed out that the allowance or deduction is made under statutable deductions. But looking to the law which bids us assume a tenant, undertakings are justified in assuming that the tenant would make the repairs daily; and it follows, as a matter of course, that he would have to find the capital for doing it. The introduction of prepayment meters, it is now argued, has been the means by which a portion of the gas receipts is collected within a fortnight, or thereabouts, of the time that the gas is consumed; and the argument is used that the amount so collected should reduce the working capital required. Probably it would have this effect; but each case would have to be decided as it arose.

Stock of Coal.—After a discussion on the previous item—viz., working expenses—which has perhaps resulted in 4½ months' allowance being made, it is customary to hear that the allowance is intended to cover the cost of coal provided for emergencies. It is a most difficult matter to convince Quarter Sessions or Assessment Committees that the coal allowed for under the head of working expenses, is simply that which has actually been carbonized; and the cost of a stock of coal required for emergencies is an item which should be allowed for over and above the cost of the coal carbonized. There may easily be a difference of opinion as to how much stock should be kept; but that some stock should be allowed is unquestionable. Gas authorities are agreed that six weeks' stock of coal, reckoned on the maximum day's make, is a reasonable and prudent amount to keep in reserve. Assessment Committees will sometimes ask: "How much coal do you actually keep in stock?" But that is not the point. If an undertaking chooses to run the risk of serious expenditure in the event of running short, this does not affect the fact that it is generally admitted that six weeks' stock of coal is what a prudent tenant would keep. It was stated, during the proceedings in a recent rating case, that the undertaking incurred an expenditure of £7000 in 1895, simply for breaking ice to allow the coal-boats to pass through. Such an expenditure would probably have been unnecessary had there been six weeks' supply of coal in stock. The point is often argued: Why take the maximum day's make; why not an average day's make? The reply is that six weeks' stock of coal, reckoned on the average day's consumption, is insufficient. If we are to take the average day's consumption, the number of weeks must be increased to ten or thereabouts.

Meters on Hire and in Stock.—A deduction is sometimes made from the original cost of the meters, varying from 15 to 30 per cent. This deduction is made because it is assumed that it is not possible to fully maintain the meters. Without objecting in any way, gas undertakings often agree to this being done. But meters are fully maintained in such condition as to register the gas correctly, and to command rent. In bulk, meters never wear out. If a meter is found to be out of order, it is replaced by another; and though the life of an ordinary meter may only be twenty or thirty years, the full number of meters required are there registering correctly, and in a condition to command a rent at the end of fifty or sixty years. Any allowance for depreciation of meters should be strongly objected to, and the full original cost of the meters claimed as part of the tenant's working capital.

One Quarter's Rent.—This is a claim which, when made, is generally objected to. To omit it, however, is a grave mistake in my opinion. The Act says we are to base the rateable value on the rent at which the hereditament might reasonably be expected to let. If it were let to a tenant, he would have to pay rent. By leaving out the claim, we are at once giving in to the method adopted by Assessment Committees, who so often take profits as their basis instead of rent. If we are to assume a hypothetical tenant, let us take him right through the valuation, instead of allowing him to be dropped when he becomes inconvenient. It is not an unreasonable thing to assume that he would, as a tenant, have to pay rent; and whether it be allowed or not, the claim should be made.

Interest on Tenant's Capital.—

2½	per cent.	for risks and casualties.
5	,,	interest on tenant's capital.
10	,,	for trade profits.
Total . .	17½	per cent.

These percentages are admitted by the Courts and Assessors generally to be fair; but attempts are sometimes made to draw a distinction between the different items constituting the working capital, and, while admitting the reasonableness of allowing 17½ per cent. on certain of these, it is argued that it should not be allowed on all. If a tenant is to be debarred from obtaining not only trade profits and a further sum to cover risks and casualties, but also interest on his capital in addition, he would not rent the undertaking, but would prefer to invest his money in a quarter where he could realize the full interest expected to be obtained in trade. To say that the full allowance should only be made on the portion of the tenant's capital—such as tools and implements—exposed to the vicissitudes of trade, and not on coal in stock, is simply to throw dust in the eyes of those concerned. The one is as much exposed to the vicissitudes of trade as the other; but any deterioration, whether it be tools and implements or coal, or any other portion of the plant and materials, appears elsewhere, and has nothing to do with this question of interest on tenant's capital. The whole of the tenant's working capital is locked up in the undertaking, and is unavailable for any other purpose, and is in its entirety entitled to the full amount which the Court decides is fair and reasonable.

These, then, are the main points of difference, and in nine cases out of ten are the direct cause of the failure to arrive at a settlement. They are the items which vitally affect the ultimate result. I do not think that any hesitation should be felt at freely discussing this question of rating. The matters named in the paper are public property. The accounts of all gas undertakings given in detail are obtainable; and there is nothing in connection with them that need be hidden from the public.

I gather from the pages of the "JOURNAL OF GAS LIGHTING" that our friends the electricians are complaining that they must deposit detailed accounts of the working of their undertakings with the Board of Trade; copies of such accounts to be obtainable by the public on payment of a shilling. This is only what gas undertakings have complied with for many years; but the electricians are taking it rather badly. Doubtless there are many matters which they would like to keep to themselves; but the Board of Trade, knowing that there is no tonic so valuable as public criticism, have ordered them to fall into line with ourselves. Turning to the returns published in "Lightning" during March, 1898, of the accounts of electrical undertakings, I was much interested to note the amounts paid by a number of them in the shape of rates and taxes.

The sums, as compared with gas supply undertakings, show a striking difference; and it is well, from our point of view, that attention should be drawn to them. I give a few examples in the following table, though anyone may

carry the comparison further on obtaining a copy of the journal referred to:—

	Profits or Net Receipts for the Year 18;7.	Amount Paid under the head of Rates and Taxes.	Percentage on the Net Profits.
Manchester Corporation.			
Gas Department	£68,325 ..	£27,0;6 ..	39·62
Electrical Department . .	16,812 ..	2,090 ..	12·43
Birmingham Corporation.			
Gas Department	£43,468 ..	£24,587 ..	56·56
Electrical Department . .	5,963 ..	882 ..	14·79
Liverpool.			
Gas Company	£104,973 ..	£17,057 ..	16·25
Corporation Electrical Department	11,376 ..	246 ..	2·16

These figures exemplify clearly the way in which gas-works are handicapped as compared with electrical undertakings; and the keen competition which we have now to face should bring home to us the necessity of freeing ourselves from the burden of unfairly heavy contributions in aid of rates.

Discussion.

The PRESIDENT said the paper before them was very important, as well as interesting. He believed that, as a rule, the amount a concern had to pay was first of all fixed by the valuator, who afterwards adjusted the figures to suit it. Some time ago, he made an attempt at a valuation on the lines laid down, and came to the conclusion that the authorized deductions would come to more than the total amount; so that really they ought not to pay anything at all. When they got to this point, they had to begin all over again. He hoped to receive in the discussion valuable information from gentlemen who had had more experience in the matter than he had.

Mr. W. CARR (Stalybridge) said it was so long since he had dealt with the subject that he feared his facts had got somewhat musty. The paper would be a valuable contribution to their "Transactions," because every now and then the people who made the assessment wanted to raise more money, and they found it very convenient to go in for a new valuation. Then the gas engineer had to look about, and try to find out how he could prevent injustice being done to his company. No doubt many works were undervalued at the present time; but it was very difficult to arrive at the right amount. It seemed to him that the law on the subject had been devised in the interest of valuers, for most people found they were obliged to obtain the assistance of experts in order to guide them through the mazes of a re-valuation. Even with their assistance they were not always fairly dealt with, and some had to pay considerably more than they ought to do. The points on which differences arose were pretty fairly enumerated in the paper; and it would be very valuable for reference hereafter, so as to assist members in coming to a conclusion as to whether or not it was worth while to prosecute an appeal. His own opinion, as he stated some years ago, was that fresh legislation was required on the subject, because gas-works were still valued on the lines laid down before they existed. But apparently it was to no one's interest to agitate for fresh legislation; and so few people in the House of Commons understood the subject that it was difficult to know whom to approach with the view of introducing a Bill. It might, however, prove to be to the interest of members of the Institute, as well as of those concerned with water supply and electric lighting, that some project of legislation should be introduced with a view to simplify the valuation of such undertakings. He hoped that such a time would come before long, even if Mr. Newbigging's business suffered in consequence; though this might not be the result after all. The chief point in the paper was contained in the table at the end, which showed how unequally gas and electric lighting undertakings were valued for rating purposes. The profits of the latter would be much reduced if they were charged at the same rate as gas companies, who were thus shown to be assisting them in a way which was not generally recognized.

Mr. H. TOBEY (Malton) said the subject before them was rather an intricate one; but he had come to the conclusion that gas companies were most unfairly assessed in comparison with most other industrial undertakings. In a recent assessment in their own town, he found this was the case as compared with breweries, mills, and other establishments. Whether he took the area of ground covered by the works, the value of the buildings, or the value of the machinery, he could not find any reason to justify the difference which existed; and when he came to the profit and loss account, it was still more inexplicable. The only possible excuse he could think of was that gas and water works had a sort of monopoly, and were not liable to the same risks as other undertakings were; and he could not see why these undertakings should not be valued on the same basis as gas-works. Several of the items mentioned in the paper were worthy of notice—for instance, the stock of coal. Six weeks' stock was certainly not excessive; if anything, it was under the mark in these days of strikes and stoppages. Mr. Newbigging had mentioned meters; and there was an analogous subject—that of gas-stoves, of which some companies had a large stock, and they should be treated in the same way. Another item for which he thought companies were entitled to an allowance was the stock of public lamps, which were now much improved, and also more costly. The lamp-posts themselves, being fixed in the ground, could not, of course, be claimed for. But certainly the lanterns ought to come in as tenant's capital; and where the company found the main cocks and connections to the meters, they should be taken into account as well.

Mr. W. A. VALON (Ramsgate) agreed that the subject dealt with was a thorny one; and the way in which the writer of the paper had presented it to the members, while it gave scope for ample discussion, did not, he ventured to think, move them nearer to any other method of assessment than the one at present existing. The writer in his opening remarks, said the method was "admittedly faulty." He then proceeded to say that, however unsatisfactory it was, there was little probability that the law would be altered. Further on, in the table of rates under A, B, C, D, and E, he gave a reason, and a very cogent one, why the law should not be altered; concluding rightly that no two cases were alike, even if the selling price was the same, and that each undertaking must be valued by considering the whole of the attendant circumstances. Following the lines of the paper, it would be very easy to make a lengthened reply to the method adopted by the writer as the proper one, in his opinion, to be pursued. It was just in this difference of opinion between gas engineers or experts that the whole uncertainty or difficulty with the question lay. Reference was made to the hypothetical tenant, to whom Mr. Newbigging referred as a very good sort of fellow. No doubt he might be; but the one character conspicuous by his absence from the paper was the hypothetical landlord. This individual was not mentioned from one end of the paper to the other; and he (Mr. Valon) ventured to think it was because they so often assumed a hypothetical tenant without giving due consideration to the hypothetical landlord that the line of deviation was so great between the advisers of a gas company and those of an assessment committee. In hypothecating to the one they should not forget the other; otherwise no fair judgment could be arrived at. He quite agreed that the amount received for residuals should be put under the head of "receipts," and not deducted from the cost of the coal. Rates and taxes, in his opinion, should be left out of the expenditure until the rateable value of the concern as a whole had been ascertained; but a proper allowance for rates should be made in the tenant's capital. Coming to the question of the stock of coal, this would, as Mr. Newbigging said, always be a difficult one until such time as companies were content to take as an allowance a stock equal to that which was actually kept, and which the assessment committees considered is to be proved sufficient by the fact that it was the practical condition under which companies worked from year to year. Again, should any outlay be incurred such as that referred to by Mr. Newbigging, of £7000 for breaking ice to allow boats to go up to the works through an insufficient stock of coal being on hand, or from any other cause, that £7000 must be allowed in the expenditure and become a deduction from the rateable value. Hence, if they claimed a hypothetical stock of coal, and at the same time the actual expenditure which might have been rendered necessary by an accidental shortage, it was clear they would make a claim for the same thing twice over. It was quite impossible for anyone in speaking to a paper like the one before them, to discuss at length all the allowances for items under the head of "tenant's capital," which Mr. Newbigging—as, indeed, everyone else—knew would be in accordance with the judgment formed by the valuer at the time of making his valuation. He (Mr. Valon) noted, however,

that the author claimed that 17½ per cent. was admitted by the Law Courts and assessors generally as the proper allowance off the total amount of the tenant's capital. He should be glad if Mr. Newbigging would point out any case he knew of where this percentage had been specifically mentioned as the proper amount. Decisions at Quarter Sessions were given as totals, without reasons attached, seeing that it was possible that the tenant's capital claimed by the assessment committee would be (say) one-half or two-thirds of that sought as the proper amount by the company or corporation. Mr. Newbigging gave these as the "main points of difference," and said that in nine cases out of ten they were the "direct cause of failure to arrive at a settlement." His (Mr. Valon's) experience scarcely pointed to this. He found the points of difference to be those which arose outside the accounts altogether. For instance, a valuer for a company, after having arrived at what would be the valuation of the concern on the face of the accounts, set to work to claim further depreciation in respect of repair and maintenance of works, a deduction for depreciation in the price received for residuals (not shown in the accounts, but which he said he thought would take place within a limited time, and for which an allowance should be made), and a further allowance in the price of coal because the market was tending upwards, and also for increased labour in order that loss from strikes might be anticipated. On the other hand, the valuer for the assessment committee would most likely claim that no consideration at all should be made, except, perhaps, for wear and tear; and that the face of the accounts should be taken to indicate the proper rateable value. Hence, as Mr. Newbigging had said, while hypothetical claims were made on one side which were not taken into consideration on the other, there must be a wide difference in the results. The verdict of the Judge might approximate to the truth—at least, they hoped it would, for the sake of their most cherished institutions; but to expect that a story which had passed through the successive media of evidence, advocacy, judicial summing up, and newspaper commentary would leave on the mind an exact impression of impartial accuracy, was to expect too much from human nature.

Mr. G. R. Love (Dundalk) thought there ought to be some simpler means of arriving at the assessment. He agreed with a previous speaker that gas companies were taxed more than private undertakings. The Chairman of his Company owned a large distillery. In 1896 the valuation of the Gas Company was suddenly raised from £400 to £1035, which meant an increase of £300 a year in rates; and on talking over the matter with him, he said his business had not been treated in the same way, though it turned over four times as much as the Gas Company. He began to wonder why there was this difference; and he came to the conclusion that it was because gas companies published true statements of accounts, which proprietors of other undertakings did not. As he happened to know the valuer, he asked him, when this great advance took place, to show him his figures, so as to see how he made it out. This he kindly did; and he found there were one or two things mentioned by Mr. Newbigging which had not been included. He might mention that they had called in Mr. Newbigging to advise them on the matter. He made no allowance for the stock of coal, nor anything like the proper amount for the quarter's rent and the tenant's capital. The greatest difficulty was this: In 1896, their profits were going down because they reduced the price of gas; but the valuer made no allowance for this, and treated it as a normal year. He (Mr. Love) thought some abatement ought to be made in such a case as this. If they had to pay on large profits when they were not making them, the matter would have to be fought out every year; and this would lead to a lot of expense.

Mr. W. W. Hutchinson (Barnsley) said Mr. Newbigging had indicated the great disparity of valuations in connection with gas companies; but they did not stand alone in this respect. The whole system was in a very unsatisfactory condition. In the preceding week, he had a conversation with a colliery manager, who pointed out to him how honest people were sometimes very much over-assessed. A seam of coal which was ordinarily 9 feet thick might run down to 5 or 6 feet, or even less; but a statement to this effect would scarcely be believed, unless it were certified by a coal valuer. He (Mr. Hutchinson) should much like to know on what basis the valuers were paid for their services. He was in a contest of this sort a few years back. They had an eighteen months' fight, and were preparing to go to the Quarter Sessions, when the Assessment Committee made terms with them; but the great difficulty they had was that they could not get from the valuers the basis on which they had worked. The Company gave every information, but could get nothing in return. It seemed to him that the secret of all this variation, or the major part of it, lay in the system on which the valuers were paid for their services. He had heard it suggested that they received a commission on the increased amount of the assessment; and if this were so, it would explain a good many things. In such a case the system ought to be altered. As to coal, he did not think that six weeks' stock was sufficient; it ought to be at least two months' supply for the maximum make.

Mr. J. P. Leather (Burnley) thought Mr. Hutchinson had gone to the root of the matter. At Burnley they had had their assessment raised continually, and had not been able to get any satisfaction. They could not arrive at the principle on which the valuation was made; and when they went before the Assessment Committee, the valuer who was present absolutely refused to state it. If any alteration were made in the law, this point should be kept in view; and the Assessment Committee or the valuer should be compelled to show the way in which the valuation was arrived at. Without this knowledge, it was impossible to decide whether or not it was worth while to take an appeal to Quarter Sessions.

Mr. J. W. Buckley (Falmouth) said he had given considerable attention to this subject lately. Many members differed as to the law of rating; but he gathered that Mr. Valon thought the law was almost as perfect as it could be, and that the only difficulty lay in the difference of opinion among the valuers. A valuer would say: "Tell me which side you want me on, and I will give you the evidence you want." He rather differed from Mr. Newbigging as to the stock of coal; for in his district, during the past three years, if he had had less than an eight weeks' stock the town would have been in darkness on three occasions. Again, he referred to the custom of collecting monthly the receipts from automatic meters; but in many cases it was usual to collect them only quarterly. The money-boxes would hold at least 15s. in coppers; and what was the use of collecting monthly if once a quarter would do? He believed it was common knowledge that in the West of England valuers were paid on the gross increased valuation they succeeded in supporting.

Mr. H. Townsend (Wakefield) said he had had some experience of valuations for assessment, and was bound to say that it was very unfair to remunerate the valuers by a commission on the amount of the assessment, more especially in the case of the gas industry. The valuer would naturally look to those undertakings on which he could most easily "put the screw;" and as gas undertakings had no friends, he turned to them first. He (Mr. Townsend) was amused to hear Mr. Newbigging describe the hypothetical tenant as "not a bad sort of fellow;" for, on going through the accounts for his Company, he came to a very different conclusion. Fortunately, he did not make the acquaintance of the other bogey to whom Mr. Valon had introduced them—the "hypothetical landlord;" and he thought they would be quite satisfied to be without him. The great difficulty was that most of these terms were so very elastic. The statutable deductions in the hands of one set of valuers represented a totally different figure from what they did in the eyes of the valuers on the other side. The working expenses, again, could be stretched on either side to an almost indefinite extent. While it was difficult to see how the present law could be amended, it was very unsatisfactory, because in every case which came before the Courts there was such an enormous difference placed on certain items by contending valuers. He had had experience of taking these questions before Assessment Committees and also before Quarter Sessions, and had come to the conclusion that it was infinitely better to try and arrange the matter with the Committee than appeal to the Sessions, for he had found more reasonableness on the part of the Committee. There were some Sessions of which, perhaps, the Chairman and members had a fair acquaintance with this subject; but, generally speaking, these cases seldom came before them, and they were perfectly ignorant of the law and of the whole question. He was much struck with this in the only case he had been concerned in before such a tribunal. Not only were

the Bench actually bewildered, but their legal adviser was also. Then human nature came into play again, and they reflected that if they let off a Gas Company which could well afford to pay, and had only to increase the price to secure their dividend, the assessment of private undertakings in the neighbourhood would have to be raised to make up the necessary amount.

Mr. Isaac Carr (Widnes) said it was evident this was a subject on which most of the members wanted information; and no one was more competent to give it than Mr. Newbigging. He had told them what should be allowed; and he (Mr. Carr) took it for granted that, in the majority of cases, this was so. But it was a subject upon which there was no positive law; and it had, in great measure, to be guided by custom. He had looked at some of the figures published by his brother in the paper to which reference had been made, and found that some gas companies were rated to the extent of 4½d. per 1000 cubic feet, while others were as low as ½d. They would all agree that it was not right for one company to be rated nine time as much as another; and he thought it would be well if the matter were discussed a little oftener. He took one grain of comfort to himself from the fact that undertakings which sold gas at cost price, being administered for the benefit of the consumers, came off best; for he found, on Mr. Newbigging's showing, that in a recent valuation of theirs, though they might quibble at certain points, he should do well to leave it religiously alone, as it was fairly low, owing to the way in which the works were administered. When the assessor took the total receipts as his basis, and made all the deductions, there was not much left for him to go upon by the time he came to the end. The comparison with electric light undertakings was certainly astonishing, and in some cases, as in Liverpool, he thought the fact could only be explained by there being some very potent influence at work to bring them off lightly. He should like to know if insurance was a statutable deduction. He believed it was common knowledge that the valuers were paid by commission on the increase.

Mr. W. Carr remarked, by way of supplementing what he had said before, that he was surprised at anyone being satisfied with the present state of the law, for very few of the valuers themselves understood it. In many cases, if a new building or a gasholder were erected, the valuer would come and look at it, and say he must raise the assessment £50. He made some show of measuring and valuing it; but he knew nothing whatever about the hypothetical tenant, or landlord either. If the Poor Law authorities wanted a re-valuation all through, they generally had to send to London for someone who knew something about it. He thought it high time the law was altered.

The President remarked that there certainly was great difficulty in understanding the lines on which valuations were made.

Mr. Newbigging, in reply, said he was quite agreeably surprised to find that speakers had kept very closely to the lines of the paper. One interesting point was raised by the President, who said that when they had made certain calculations they found they had not any rateable value. This was the case with a good many undertakings owned by local authorities, where they were yielding no profits—in fact, they had no rateable value. But it seemed unfair that an undertaking enjoying all the privileges of a town should be exempted from rating; and consequently it was agreed that a certain sum should be fixed. It was, however, quite illegal, and not at all in accordance with the Parochial Assessment Act. Mr. William Carr had raised a point about extensions of works, and the valuer raising the assessment. Such a course was entirely unjustifiable. If the extension were carried out judiciously, it would show itself in an increased profit in the accounts, and would rectify itself in that way. Similarly, if an undertaking had a very considerable amount expended (say) in a large retort-house which was not being utilized, many directors thought that they should have a reduction on this ground. But no one could support such a contention. He quite expected that someone would have pointed out why electric lighting undertakings escaped so lightly in the matter of rating. It was in part, and chiefly, due to the fact that the tenant of such an undertaking required considerably more working capital then he would need in the case of gas-works. No doubt careful "nursing" had also something to do with the matter. In regard to the stock of coal, he did not say six weeks' store was sufficient. He put it as the minimum which a prudent tenant would keep; and if they tried to argue the matter out with a valuer, and he would allow any more, they might consider themselves fortunate. He agreed that six weeks' stock of coal was quite insufficient in some cases. With regard to the mode of payment, he could not say how Union valuers were paid; but, speaking for themselves, they were very much underpaid, considering the amount of thought and care which they had to give to the question.

Mr. Hutchinson said he did not refer to Mr. Newbigging at all, nor did he mean to impute motives to anyone; but if valuers were paid in the way suggested, it was only human nature to make out the best for themselves.

Mr. Newbigging said he believed some were paid in this way, and some not. There were different methods employed in various parts of the country. There was no doubt at all that insurance would come under landlord's deductions.

THE WORKMEN'S COMPENSATION ACT, 1897.

By C. S. Ellery, of Bath.

This Act, which comes into operation on the 1st day of July, having established the principle "that the pecuniary burden of accident shall fall, as a first charge, on each industry to which the Act applies," it is not now proposed to discuss the ethics of the subject, but rather to consider the liability of gas undertakings under the Act, and how best to meet the claims which may arise. The following are the chief features of the Act.

If personal injury by accident arising out of, and in the course of, any employment to which this Act applies is caused to any person engaged, whether by way of manual labour or otherwise, and whether his agreement is one of service or apprenticeship or otherwise, and is expressed or implied, his employer shall, unless the injury is attributable to serious and wilful misconduct, be liable to pay compensation as follows:—

In Case of Death.

1.—If any dependents are left, not less than £150 or more than £300.

2.—If any persons partially dependent, any sum that may be agreed, or allowed by an arbitrator—not more than £300.

3.—If no dependents are left, expenses of medical attendance and burial—not exceeding £10.

In Case of Incapacity for Work.

A weekly payment, after the first two weeks of disablement, not exceeding 50 per cent. of the average weekly earnings (not to exceed £1 per week) during the incapacity. This may be redeemed after the weekly payments have been continued for not less than six months by the payment of a lump sum, to be settled, in default of agreement, by arbitration.

While the Act thus throws new and additional liability on gas undertakings, it will be of some service at this point to state the experience of a few representative works during the past five years, both as regards the number and the nature of accidents on account of which the companies would be liable to pay compensation under this Act. It remains to be seen whether, and to what extent, accidents will increase; and it will be an advantage to bring to light the actual state of affairs prior to the working of this amended law, if only for purposes of comparison later on. To this end inquiries have been addressed to several gas-works, and the replies are appended hereto in a tabular form.

Perhaps the first thought suggested on looking through the returns is the comparative safety of employment in gas-works. Happily only four fatal accidents have occurred during five years in these 15 works, which over that period paid out in wages not less than £1,250,000. Assuming the maximum compensation of £300 had been awarded in each case (though this will probably not be so in practice), it would work out to something under 2s. per cent. on the wages paid. As companies will continue to "take the utmost care to see that accidents are avoided," and as the tendency will doubtless be to increasingly employ labour-saving machines, and methods of manufacture requiring less men, as the onerous demands of modern legislation become more and more pressing, this figure of 2s. may be considered safe for the purpose of estimating the liability so far as fatal accidents are concerned.

No.	1893.				1894.				1895.				1896.				1897.			
	Fatal.		Total.	Partial.	Fatal.		Total.	Partial.	Fatal.		Total.	Partial.	Fatal.		Total.	Partial.	Fatal.		Total.	Partial.
	No	Compensation.	No.	Compensation.	No.	Compensation.	No.	Compensation.	No.	Compensation.	No.	Compensation.	No.	Compensation.	No.	Compensation.	No.	Compensation.	No.	Compensation.
1	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
2	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	1 ..	Nil	Nil	Nil	1 ..	Nil	Nil	Nil	2 ..
3	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	2 8/15/0	Nil	Nil	Nil	2 3/8/0
4*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
5	Nil	Nil	Nil	no record	Nil	Nil	Nil	no record	1	None	Nil	no record	Nil	Nil	Nil	no record	Nil	Nil	Nil	12 30/0/0
6	Nil	Nil	3	10/3/0	Nil	Nil	1	13/18/3	Nil	Nil	Nil	Nil	Nil	Nil	2	25/19/6	Nil	Nil	Nil	Nil Nil
7	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil Nil
8	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	6 ..	Nil	Nil	Nil	Nil	Nil	Nil	Nil	12 ..
9	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil Nil
10	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil Nil
11	Nil	Nil	Nil	18/0/0	Nil	Nil	5	25/10/0	Nil	Nil	Nil	4 17/0/0	Nil	Nil	Nil	6/12/0	Nil	Nil	Nil	6 20/0/0
12	1	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	1 Wages	Nil	Nil	Nil	Nil Nil
13	1	74/5/6	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	1 ..	Nil	Nil	Nil	2 ..	Nil	Nil	Nil	1 ..
14	Nil	Nil	..	..	Nil	Nil	..	..	Nil	Nil	..	..	Nil	Nil	..	..	Nil	Nil	..	..
15	Nil	Nil	Nil	..	Nil	Nil	Nil	..	Nil	Nil	Nil	..	1	10/ week for 12 years	Nil	..	Nil	Nil	Nil	..
16	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil Nil

* Details not kept.

Unfortunately, the Act makes no provision for periodical payments in lieu of a lump sum. While the receipt of such a sum as £300 by the widow of the victim of a fatal accident would certainly add interest to the matrimonial market, it might not prove the surest way of ministering to the well-being of the widow; and probably if some pension scheme could be shown to be more favourable to the dependents than a lump sum, the Registrar of Friendly Societies might sanction an arrangement which would spread the payments over two or more years.

Turning from fatal accidents to those resulting in total or partial incapacity for work, the liabilities are more indefinite; and the statistics have to be used with still greater caution in attempting an estimate of future risk. Taking the number of accidents as they stand—although it is probable in some works a strict account has not been kept of the more trivial accidents—estimating the time of disablement at four weeks (a figure for which I am indebted to Mr. G. Livesey's report on the working of the South Metropolitan Gas Company's Accident Fund), and computing the compensation at the highest rate of 20s. per week, the cost would work out to less than 8d. per cent. on the wages paid. Taking these two figures together, it appears that a rate of 2s. 8d., or (say) 3s. per cent. would amply cover all risks on the new schedule of rates set forth in the Act. It remains, however, to be revealed to what dimensions the risks may grow as the Act runs its course. Uncertainty exists on several points.

(*a*) For instance, What may be the definition of an accident? This difficulty is pretty certain to crop up; and as shown in Mr. Robert Jones's handbook on the Act, though in many cases no uncertainty will exist, yet it will puzzle the cleverest doctor to pronounce judgment when the illness may be due to one of several causes.

(*b*) Again, the scope of the Act is extended to embrace *all* accidents not attributable to the serious and wilful misconduct of workmen, even if caused by *any* person, whether in the employer's service or not; and the liability is not now limited to workmen engaged in manual labour. The definition of "workman" is given as meaning "every person who is engaged in an employment, whether by way of manual labour or otherwise, and whether his agreement is one of service or apprenticeship or otherwise, and is expressed or implied, is oral or in writing," which will include salaried officers, clerks, &c., if not even directors.

(*c*) The inducement to malinger will be greater after the 1st prox., inasmuch as employers will be responsible for the negligence of men as well as carelessness; and since in gas-works the employment of many hands is for the winter months only, some workmen may not have the moral strength to resist being led into temptation, especially in cases where they receive an allowance from one or more benefit societies in addition to compensation awarded by an arbitrator under this Act. The prospect of a holiday on an income only slightly less, or perhaps more than, his full working wage, and with nothing to do but, say, nurse a damaged finger, will have a real fascination to some men who lack the grit to be found in the average British workman.

While these added risks or liabilities cast upon employers by the Act create some uncertainty, there is, on the other side, to be noticed that "the employer shall not be liable in respect of any injury which does not disable the workman for a period of at least two weeks from earning full wages at the work at which he was employed." This is a wise provision, which will partly remove temptation from the weaker workmen, and must lessen the risk and amount of compensation under the Act to a considerable extent.

And, again, the difficulty felt more or less in the past with doctors, many of whom have been but too ready to put men on the sick-fund for the slightest complaint, will be largely removed by the decision of the Secretary of State to appoint Medical Referees, to be paid by the Treasury—"men of independent position and high standing," whose duties and qualifications will be clearly defined, and to whom reference may be made by Committees, Arbitrators, or Judges of County Court, instead of as has been too often the case to young and inexperienced house surgeons in hospitals. It must also be borne in mind that, in the majority of gas-works, when men have been seriously injured some compensation has been voluntarily paid before this Act was thought of, either through a sick-fund or otherwise; and therefore any payments under

the Act will not be entirely new, although perhaps an extended charge on the undertaking.

Having looked frankly at both sides of the question, it remains only to inquire how best to meet the liability and risks which may arise. Much has been written on the subject of the rates proposed by Insurance Companies, and many useful suggestions thrown out by the technical Press, by Mr. Bower in his paper before the North of England Association of Gas Managers, and by others; and the more the subject is looked into, the clearer it becomes that, as the "JOURNAL OF GAS LIGHTING" rightly says, in concluding an able article on the subject: "This is not a consideration to be lightly dismissed"—not only because of the proposed premiums, but because of the terms Insurance Companies may find it necessary to impose, until some experience is gained of the real risks they run.

Experience of insurance against claims under the Employers' Liability Act tends to show that the Insurance Companies, rightly enough, take care of themselves first. In a works that need not be named, an insurance was effected with a leading Office against risks under this Act. In eleven years the sum of about £150 was paid in premiums, while only one claim had to be met, involving a payment of £10. This looks more favourable to the Insurance Company than the insuring gas-works; but the disproportion is small when compared with the rates now proposed. Instead of £150, the premiums would be many times greater; those first suggested being sufficient to compensate for killing one man every two years, or disabling four men annually.

Already the Insurance Companies are naming lower and special quotations; and especially interesting is the sliding-scale submitted to the members of the North of England Gas Managers' Association. But unless the premiums are still further reduced, or the Government interfere and take the insurance of employers risks, gas companies should seriously consider the question of becoming their own insurers, either in a mutual fund or independently. In a letter received from Mr. George Livesey, in which he expresses his assent to this view, he also reiterates the opinion that in any mutual scheme it would be an advantage to include workmen.

It is clear that the smaller works will be in a different position to works employing (say) from 80 to 100 men, and over; but looking at the statistics given in this paper, and making full allowance for the uncertain risks already referred to, the conclusion arrived at by the author is that works with a wages-bill of (say) £8000 per annum and over cannot be taking a too serious responsibility in facing the situation as self-insurers, at any rate until the working of the Act has been somewhat tested.

Supposing such a works put aside 10s. per cent. on £8000, this £40 per annum would be sufficient, under favourable conditions, to build up in a few years a fund equal to any contingency likely to occur; and should it unfortunately happen that in the first year or so any serious claims be made, recourse might be had to the reserve fund, which, under the Gas-Works Clauses Act, 1847, may be used "to meet any extraordinary claim or demand which may at any time arise against the undertaking." Or even without building up an insurance fund, such companies might fall back on the reserve fund, if the gross profits of any half year happened to be insufficient to meet the charge of dividend and interest in consequence of an abnormal number of accidents.

In cases of companies having insurance funds for other purposes, there appears to be no reason why such funds should not be used for claims under this Act, because—again quoting Mr. Livesey—"there seems no distinction between losses incurred by accidents to plant and to men in the conduct of the business." In the case of companies with a low or depleted reserve and a comparatively small wages-bill, it may be a bad blow if the misfortune of a fatal or serious accident occurred before provision had been made in the shape of an insurance fund. The suggestion that such companies should form a mutual fund seems admirably suited to meet the situation. Spreading the liability over a number of small works would put each in a position of strength. The experiment is to be tried by the Federation of Engineering Employers; and the rate to be charged for the first year is 12s. 6d. per cent. The cost of management, if undertaken by a Committee of officers from each gas-works insured, would not be great, and, if necessary, an inspector might be appointed to investigate cases and report; or it is a question well worth consideration whether such a fund might not be entrusted to the care and control of the Council and officers of the Institute, or even of the District Associations. The advantage of such a fund over insurance with any Society is apparent in that, if the premiums first arranged are found to be unnecessarily high, the surplus funds will remain the property of the several insuring companies or corporations, and premiums would be adjusted from time to time according to circumstances, without the restrictions which would be imposed on such gas companies or corporations insuring *en bloc* with any insurance society. This consideration has the more weight when it is borne in mind that, in the event of an insurance society becoming insolvent—whether brought about by accumulating liabilities, in the more dangerous trades, without proper reserves, or otherwise—the responsibility and liability under this Act will fall back upon the individual works in which the man claiming compensation was engaged.

Discussion.

Mr. J. P. LEATHER (Burnley) said that no doubt all the members had considered this subject more or less, especially as it had been dealt with in the technical papers, both in leaders and correspondence. His own Committee had it now under consideration. He thought the suggestion in the paper was the right one—viz., that gas-works paying over £8000 a year in wages would do best to insure themselves. How smaller works would be affected by the Act was quite a different consideration; but the premiums required by the Tariff Offices would require a payment of £250 a year in his case, which was quite an absurd figure. He had had all the accidents which had occurred at their works during the last thirty years taken out as carefully as possible—partly of course from memory, but they had men now in their employ who had been there all the time, and he believed that up to twenty years the list was quite accurate. He went back to thirty years in order to include a death and a rather serious accident, and thus make the figures as bad as possible. In the thirty years they had one death and one permanent partial disablement. What this would have cost them under the Act, it was difficult to say; but he thought whether they were bound to pay or not it was far better to keep the thing in their own hands if possible. If they insured, and a man had an accident, they would have to send him to the Insurance Company, who would knock him down to the lowest figure they thought he would not appeal against. In this way there would not be that link which there ought to be between employer and employed. Even though they were bound to pay the amount, when they handed the man his pound a week, or whatever it might be, he would say "thank you;" and they would miss such an expression by sending him to an Insurance Company. Besides the one death and one total disablement at Burnley, there had been 20 temporary disablements of over two weeks, and 12 of under two weeks; and possibly there might have been a few more of such a trifling character as to escape notice, which would not come under the Act. In nearly every case they had paid. In a few cases only, where it was admittedly their own fault, the men had neither asked nor expected compensation. In most cases they paid half wages; in some serious cases, full wages; and in one case, the doctor's bill as well, which was more than double what the Act compelled. Taking everything into account he did not think they would have anything more to pay in future than they had paid in the past; and it would certainly not be anything like £250 a year. In cases of permanent partial disablement, the man was not always obliged to be idle. Even if he lost an arm or a leg, something might be found for him to do; and though he was not paid what he would have earned if uninjured, still he had some occupation for which he was fairly paid. This made him happier; and it cost less than it would do under the Act. In the one case of permanent partial disablement, the man received more than he could get under the Act—viz., 12s. a week and house-rent for the rest of his life; while on the other hand they had the benefit of his services.

Mr. C. A. CRAVEN (Dewsbury) said they had had very few cases of any magnitude for some years; and he should think 9d. per cent. would have provided the whole compensation they would have had to give under the Act. He thought probably there would be more claims in future; for he was somewhat of the opinion of a doctor he knew.

This gentleman told him that if he had a working-man patient who was in one club, there was a good chance of a speedy cure; if he were in two clubs from which he drew sick pay, it was more difficult; and he would defy any medical man to make a speedy cure of a man who was in three clubs. He therefore expected there would be more frequent demands made, when men knew there was an Act of Parliament which gave them a right to compensation in certain cases. Still, with reasonable treatment with a good steady class of men, he did not think they would suffer very much. Even if the Insurance Companies charged 10s. per cent. at first, when they found that the claims did not come to more than about 2s., they would probably come down to a more reasonable figure. It was not after all a very great tax on gas undertakings; and personally he should be pleased to feel that the workman had a claim, because the hearts of directors were sometimes not very tender, and they were not always inclined to give as much compensation as perhaps they ought. If they could insure for 8s. or 10s. per cent. and put both employers and employed in a satisfactory position, it was not a very great incubus on the undertaking.

Mr. W. H. Y. Webber (London), asked for his views on the subject, said, in the first place, he altogether disagreed with the author's general conclusions. He suggested that companies, and presumably corporations also, should form a combination to meet what seemed to him to be mainly an imaginary set of new conditions which might arise when the Act came into force. He thought a good deal of what had been said about the probable operation of the Act was only "bogey." On carefully looking into the matter, he thought it would be found that the Act had no terrors at all for the good employer—especially such employers as gas companies and corporations had usually shown themselves to be. He had always thought that the Act was intended to bring the bad employers into line; and it no doubt illustrated the truth of the saying that "hard cases make bad law." If this were a bad law, as some people thought, it was undoubtedly passed because of the hard cases of many men who had been killed or injured in the ordinary course of earning their livelihood, and were thus deprived of any redress; while, if it had not been in the course of earning their living, they or their representatives would have had a claim on the employer. This they were debarred from, under the legal doctrine of "common employment." He did not think gas managers at any rate had acted much on this principle, and it must be a very poor mutual scheme indeed in connection with a gas-works which would not offer very much greater advantages to the workmen than they could get if rigidly confined to the provisions of the Act. He thought any company who might contemplate the establishment or the continuation of a scheme of their own, would not have much difficulty in obtaining the sanction to it of the Registrar of Friendly Societies. The Act was really very bare; and what with the provision that a man could get nothing for the first fortnight, and another provision which had only recently been brought to his attention—that an employer could make a man go before an arbitrator, who should assess exactly what he was worth or was capable of earning, and fix the compensation accordingly—the workman did not get very much beyond the legal right to compensation which he did not possess before. He was therefore by the Act put much more on an equality with his employer, and could bargain with him; he was not a mere suppliant for mercy. But the employer was not bound to take his valuation; and if there were any dispute, it would be referred to arbitration, and there the man's expectation of being able to earn something by doing light work in the manner mentioned by Mr. Leather, and probably the fact of his being in receipt of a compensation allowance from any other source would all be taken into account, and the arbitrator could charge the employer what he thought fair. The employer was not, however, bound to provide the man with light occupation. If he had lost a leg, and could only stand and open a gate, and earn 5s. a week at that, if he could get it to do, the arbitrator would take that into consideration. So far as the gas industry was concerned, the proper way of looking at it was to regard it as a new variety of rating. They paid rates now—or rather the consumer did, and the consumer would have to pay this. It was a very small matter after all. The Insurance Companies might have some peculiar notions as to the risk of employment in gas-works with which none of them would agree. They might think gas-works were very hazardous places; but when they found that it was all ground-work, no ladder-work (he might say, by the way, that labour-saving machinery would not reduce the risk, but would rather increase it), they would perhaps be more moderate. But even so, he thought every gas undertaking could afford to take its own risk. He would not put any limit on the size of the works, because the risks must be proportionate. In small works they would be lighter than in large ones where there was much more machinery. He thought every gas undertaking could afford to stand on its own bottom—at all events for a time, until they saw what the risk amounted to. It was a charge which came out of gross profits, and was distinctly within the terms of both the Acts of 1847 and 1871, and also of the Model Act under which all sliding-scale gas companies worked. There could be no doubt that it was a form of insurance; and funds set aside to meet any extraordinary expense would certainly be applicable. Therefore he thought gas companies might go on just as comfortably as before; and if they had to pay compensation to workmen, it was a charge on the industry. He did not see any necessity for making mutual arrangements which might cause more trouble in practical working than was obvious at first sight. For the present it would be far better for gas undertakings to insure themselves.

Mr. W. A. Valon (Ramsgate) said that Mr. Webber's observations were so completely in accord with his own views that it was needless for him to detain the meeting by repeating them. In a long experience of gas-works he had not found that risk which all at once seemed to have sprung into existence in the minds of some engineers and managers, from the fact of an Act having been passed by Parliament last session. In no gas company that he had ever been connected with had there been any meanness, if he might call it so, in connection with a legitimate accident. There was a great deal of force in the remark that there were various employments in a gas-works, and it was not necessary for a man to remain during his whole life in the same position. When a stoker got beyond the hard manual labour involved in stoking, he might be put to some lighter work in the yard, or at the gate. He knew of one large company where they would be astonished to know the number of men still upon the books and doing useful work, who would in other factories have had to be sent adrift—not in consequence of any accident, but simply because the men had been a long time in their employ. He thought they would be pretty nearly unanimous that they had better insure themselves; but he was not sure that in a very small works it might not be advisable for them to pay a premium to some good office for the first two or three years, until they saw how things settled down, in case they should be hard hit. The premium would not hurt them very much; and in a few years they would see better how they stood. When the last Employers' Liability Act came in force, there was a regular *furore*—every one went in for insurance, and hundreds of pounds were paid which were never received back. He thought they would have very little more to pay in the future than in the past; and whatever there was could be made up by an insurance fund, added to those already in existence, which would be allowed by any fair-minded valuer on the transfer of the works.

Mr. John West (Manchester) said he had had something to do with the mutual insurance arrangements in connection with the Federation of Engineers. For many years past the Engineering and Iron Trade Association had a mutual insurance fund of their own—insuring themselves; and of course there were no expenses except for the office. In this way, a large sum of money had been accumulated as a reserve; and it had recently been decided that this should form the nucleus of a reserve fund for the whole of the Federation of Engineering firms throughout the country—the federated firms who fought the recent battle having now joined this Mutual Insurance Association as stated in the paper. The figure given, however, was not quite correct. The experience of the past had given an opportunity of ascertaining what accidents occurred, and of seeing what was a proper premium to pay. They had three scales—9s., 10s., and 15s. 6d. (not 12s. 6d. as had been stated). No one knew exactly what would be the effect of the last Act; but they had arranged the 9s. as a starting point, believing they would be able to reduce it one-half after a few years. They paid all their own money

in; and there it would remain to reduce the premium in succeeding years if accidents did not occur to exhaust it. It was quite different with insurance companies. They had to live out of the business; and they dare not take too much risk on themselves. He was satisfied that, both on economical and other grounds, it would be an advantage for gas companies and corporations to form mutual insurance funds among themselves.

Mr. W. HARDIE (North Shields) considered Mr. Ellery had done good service by preparing his paper, though it seemed very doubtful whether they all agreed with the opinions expressed. He was much inclined to agree with Mr. Leather, that accidents which happened at a gas-works to a workman ought to be compensated for by the gas industry itself, and that the workman should not be the sufferer. Whether or not it was best to insure with an outside company straight away, or form a mutual insurance fund, such as the Federated Engineers had done, was a point on which he still felt some doubt. But one thing was quite certain, that a gas company of the smaller size (and he should put it rather higher than Mr. Ellery did) ought to be insured in some way or other. Accidents did occur; and if in times past most of them had been very lucky in having no accidents, that might not continue, and they should be very careful about undertaking the entire risk. He had not been so fortunate as previous speakers. During fifteen years they had not one single accident at North Shields; but in the last five years they had not been so fortunate, and he believed the rate with them would have worked out under the new Act at something like 50s. per cent. He therefore thought it advisable to insure, and his Company had decided to join the combination got up by the North of England Gas Managers' Association, because in this case the rates were very fair, and the security was good.

The PRESIDENT said there were so many other gentlemen who would like to speak on this important question, that he thought the discussion had better be adjourned until the following day.

On the proceedings being resumed the next morning,

Mr. J. H. PENNEY (South Shields) said he had had something to do with the North of England Association scheme initiated by Mr. Bower, and should like to say a word or two about this question. A great many gas companies were awaiting the outcome of this paper; and he trusted the information to be gathered from it and the discussion would prove of service. Through the medium of the Press, the scheme he had just referred to had been fully explained; and he need not go at length into the particulars. The essence of it was to obtain as low a rate as possible for insurance under the new Act; and the way proposed was to ask the North of England gas companies to combine, and get a reduced scale from the Insurance Offices. Up to the present time, they had succeeded in getting a maximum rate of 10s., and a minimum of 8s. per cent. The Tariff Companies asked as much as 25s., which was preposterous. Many gas companies said that if they could get the rate down to 10s., they would be willing to join; but when this had been obtained several of the companies were raising the query as to whether the Insurance Companies were trustworthy and *bonâ fide*. The Committee of his Association went very carefully into this matter, and investigated the status of the Insurance Companies, and they found it very satisfactory indeed. He thought there had been too much panic about the Act; and gas companies might be somewhat to blame for the high quotations given, by rushing in for them. If they had waited a little, they would perhaps have had lower quotations to start with. In the North of England district there were 220 gas companies and local authorities supplying gas to whom he had communicated; and his correspondence had been rather voluminous. Very great differences of opinion had been expressed. One correspondent, for instance, said that he thought gas companies did not come within the Act, and asked if they had consulted a solicitor. His reply was, that he thought the high authorities who had written in the "JOURNAL OF GAS LIGHTING" on the subject showed there was no doubt about this. They could not ignore their responsibility under the Act; but it was well known that there had been great immunity from accident in their industry. The South Shields Gas Company went into the matter, and found that their expenditure on this head over the past seven years was very trifling; and under the Act it would have only meant a premium of 1s. 1d. per cent. They had been paying 1s. 6d., and before that 2s.; but having pointed out to the Insurance Company that there had been no accidents, they reduced it to 1s. 6d. Of course, there were extreme cases—such as that quoted by Mr. Hardie—where there was serious loss of life; but such a case might not happen again for a hundred years. He therefore hoped it would not go abroad that such accidents were a general feature of gas manufacture. He was pleased to hear Mr. Webber state that the ordinary insurance fund was applicable to the purposes of the Act. At South Shields, they had an insurance fund; and he advised his Directors that it could be used, as an accident was certainly a case of "an extraordinary demand." He did not think gas companies should convert themselves into insurance companies; they might just as well make their own retorts. Experience would be the best teacher; and if gas companies were to insure for a year, so as to make themselves safe, no doubt the rates would settle down as they did under the old Act. There were great diversities of opinion as to what the rate should be. Some said 5s., and some went as low as 9d.; but that was out of the question. It had been suggested that there would be malingering under the Act; and that it was only human nature. But there were many safeguards provided; for instance medical officers would be appointed to investigate strictly all claims made.

Mr. W. J. RUSSELL (Croydon) said that he had carefully taken out the payments made from the mutual fund of the Croydon Gas Company and the workmen for the last twelve years, and found the total sum paid for injuries alone was equal to about $\frac{1}{8}$ per cent. on the wages paid. There had been no death from accident during that time. He was in favour of continuing the payment for injuries out of the mutual fund, in order to preserve good feeling between the employer and employed, and also because he thought it would be to the advantage of his Company.

Mr. R. WATSON (Hertford) desired to express the view taken of this matter by some of the smaller gas companies. The advice given by gentlemen who represented a larger scale of operations was no doubt sound and reasonable, but only where the scale of operations was so considerable as to warrant the provision of a large accident fund. In the case of a small company where there was no reserve, or only a small one, the difficulty was much greater. Assume the case of a works carbonizing about 3000 tons of coal per annum, and having no accident fund or reserve. They would come under the table at the end of the paper; and in No. 13 they found in the first year shown, there was a fatal accident for which £74 5s. 5d. was paid. Under the new Act, that would have been at least £150. In each succeeding year there were cases where accidents had happened (although apparently no compensation was paid), which under the new conditions would have necessitated some payment. In this particular instance the difficulty in the case of a small company would be considerable. Where £150 had to be paid during the first year, and there was no fund to draw upon, it would probably mean a reduction of $\frac{3}{4}$ or 1 per cent. in the shareholders' dividend; and it would be extremely hazardous to form a suspense account, in view of the possible contingency of some similar accident in the following year, or even in the same year. The advice to small companies not to insure was, therefore, in his opinion, dangerous; and he should certainly advise them to insure. They were all desirous of reducing their charges to the minimum, and it was therefore necessary to look seriously into the best way of insuring against such accidents. They did not want to be at the mercy of Insurance Offices; and the only way to get out of the difficulty was by combination. If the smaller companies would combine, somewhat in the way suggested by Mr. Penney, a large fund would be provided on which they could all draw. The manager of a small works was in a position of peculiar difficulty, because if an accident occurred on July 1, and no provision had been made for it, it would not only interfere with the profits, but he would probably incur serious blame at the next shareholders' meeting. An insurance scheme was in course of formation by the new Gas Companies Association; but what, he asked, was The Gas Institute established for, unless it were to deal with such matters as this? By the introduction of Mr. Ellery's paper, it evidently sanctioned the discussion of legal questions, and it appeared to him it would not be difficult for the Institute to take action in the matter. He should like to know whether the scheme

initiated in the North of England could be participated in by gas companies irrespective of locality.

Mr. PENNEY said any gas company could join the North of England scheme. The greater the number who joined, the lower would be the premium.

Mr. J. KEEN (Wigan) said when the new Act was first brought forward, it was thought that no trade would be so heavily hit as the coal trade; and they were the only people who took any active steps to deal with the Bill in its passage through the House of Commons. They spent three months in fighting it, they interviewed M.P.'s by the dozen, and got all kinds of promises. But "the gentleman from Birmingham" had made up his mind that the Bill should go through, right or wrong, and they did very little good by their opposition. In the coal trade, there was an association called the Miners' Permanent Relief Society, which had existed for twenty-five years, and every case of accident had been compensated on a scale more liberal, he believed, than that of the present Act. In cases of death, the widow had 5s. a week during widowhood; and each child under thirteen years old, 2s. 6d. a week until that age was reached. In cases of accident not fatal, the man had 10s. a week and the doctor's fee. They had therefore at command statistics which were of immense value in judging what the effect of the new Act would be. During last year the working of the Society (and having been established twenty-five years it was not likely to be worse) had cost £19 4s. 2d. per head. If all concerned had joined together early enough, a better impression might have been made on the Government; but as it was, the only two alterations they secured were that there should be no compensation paid for the first two weeks, and another thing not mentioned in the paper, but which he thought was of vital importance—viz., that so soon as a man who had been injured recovered sufficiently to do some light labour he might be taken before an arbitrator, who would determine what he could earn at some suitable occupation if it could be found for him, but there was no obligation on the employer to find him work. If the arbitrator said he could earn 5s. or 6s. a week, that sum was deducted from the amount the man received. This was a very important point with regard to the amount of compensation, which some people thought excessive. Unless a man suffered injury to the spine, or some special form of damage, he was soon able to do something. Hitherto it had been the rule to find him some light employment to take him off the Society; but that clause would make a great deal of difference in what it was going to cost. In the coal trade, there were one or two different schemes. One was to insure at 8s. 3d. per cent. against all fatal accidents—dealing with other accidents themselves. The discussion he had heard that morning rather pointed to the possibility that small gas companies might be somewhat heavily hit; and that was a most important point to consider. He would suggest that they should ascertain what Insurance Companies would insure them for against fatal accidents only; and then they would not have any large lump-sum to pay. He felt certain they would be able to deal with non-fatal accidents themselves, from their knowledge of the men, and their intimate connection with them, much better than by joining an Association. He did not think the cost to gas companies would be very serious. In their (miners') own case it would cost a considerable amount of money; but they came to the conclusion that they could settle cases much easier themselves than if they were settled through the medium of any third party. One feature of the Act was to his mind most objectionable—viz., that it must have the effect of widening the breach, which each day appeared to be increasing, between capital and labour—between master and servant. The mutual schemes which would be broken up, and the angry feelings which would arise through the Act, no one could foresee; and no doubt it would bring about an amount of suffering and misery which he did not think the framers of the Act realized. As far as the coal trade was concerned, it might be taken that they would sack all their old workmen. The Permanent Relief Society's statistics showed that, of total disablement cases, over 60 per cent. were to men more than 50 years old. Certain diseases which all people were subject to, accounted for a large percentage of the relief fund; and as the Act was attacking their pockets, they were bound to take the utmost precaution to get out of it as cheaply as possible. He feared there would be many people who would find themselves out of work early in July, who would otherwise have been earning an income. There was not the same risk with gas companies as in collieries; but he thought even gas companies would be wise to make strict inquiries as to the condition of health of the workpeople they engaged, and as to their age, &c. A man's hearing and eyesight were not as good, nor was he as active, when he got past 50. In all these ways, he feared the Act would go a long way to widen the difficulties they were labouring under to-day betwixt employer and workman. Strong gas companies need not insure at all. But small ones would find it necessary to do something; and he should say the best way would be to insure against fatal accidents only, for which he thought the premium would not be very high.

Mr. H. GREEN (Preston) said they were much indebted to Mr. Keen for his observations and suggestions. On the previous day, Mr. Webber expressed the view that it was not desirable at present for gas companies to insure; and he (Mr. Green) quite agreed with this up to a certain point. But there were circumstances which might alter it. Accidents had been spoken of as if they were isolated—just one death or one injury; but sometimes this was not the case. His arrival in Preston many years ago was marked by an explosion of a gasholder, which was a very serious matter. Several men were injured by the accident, and one or two lives were lost. This would become a serious question with some companies. A large company might stand it. But the smaller companies were in a different position; and in view of an accident of such a character, which might very occasionally occur, it was most desirable that insurance should be formed of some kind or other. With regard to insurance, it was important to bear in mind two points—first, the stability of the Insurance Company; and, secondly, supposing the gas companies insured with one company, and wished to change the office, there ought to be a thorough understanding that when the exchange took place the first company's liability should still be continued, because no doubt many of the companies, if not carefully looked into, would say, "You have stopped paying the premium; and we must stop the payments in your cases of injuries;" and thus there might be cases in which an annual payment had to be made which might be repudiated. It would be very desirable either that the Institute or groups of gas companies should form an Insurance Company or have some fund to meet these cases. A good deal had been said as to the premium to be charged; and about this there was great diversity of opinion. From some inquiries he had made, he found the premiums ranged from 10s. to 25s. per cent. of wages paid. In a company with a wages bill of £10,000 to £12,000, 10s. per cent. was a matter of £50 or £60 a year, which was not a very large sum for such a company. But it was a serious matter for a small company who might be utterly ruined from an accident if they had only three or four men on the place, and one was killed or injured. It was, therefore, desirable that they should join some combination.

Mr. KEEN said, with regard to Insurance Companies, they had done a good deal of looking about to see the best they could do; and there were one or two points to be borne in mind. It must be remembered that these offices would only take a fatal risk if the man died within twelve months of the accident. If he lived over that time, and then died, the insurers had to take the responsibility on their own shoulders. Another condition was that they bound themselves to assist in the Law Courts to fight any case the Insurance Company wished to fight. If the gas companies did wish to insure, the larger the wages-sheet by a combination of companies, the better terms they would get from the office. The collieries took a wages bill of a million and a half annually, and got a considerable rebate compared with what they would have paid if taken singly, because there were no agents required. If gas companies wanted to insure, therefore, they would do it at less money by combination; and he should recommend them to go to one of the tariff offices, or several of the best offices joined together, so as to get good security. They had individual offers of 6s. and 7s. per cent. But the capital such offices possessed was not considered sufficient to cover the risk; and so they went to a tariff office as being more secure.

Mr. T. CANNING (Newport) said, as far as he could judge of the opinions expressed, it seemed it would be better for gas companies whose wages bill ran to about £8000 a year

to look after themselves, but below that amount to form associations. In the South Wales coalfield there was a scheme proposed by the owners; but unfortunately just at the time it was proposed the wretched strike now existing broke out, and stopped it. The proposal they made was so novel that it would be interesting for the meeting to hear it. In South Wales and Monmouthshire there was a Permanent Provident Fund managed by the miners themselves, though it was not solely supported by them. The miners proposed that a Mutual Insurance Society of a novel type should be formed between the Permanent Provident Society and the Coal Owners' Assurance Society. The men were to contribute 1½d. a week, and the masters to pay a guarantee on the formation of the Society at the rate of £50 per annum for every hundred men employed; and it was proposed that the management of the fund should be entirely conducted (subject to the rules laid down by the Mutual Insurance Society) by the officers of the Miners' Permanent Provident Society. This was a novel scheme; but it had a great deal to recommend it, and it would be earnestly desired by all in South Wales and Monmouthshire that it should be carried out. It made the workmen their own insurers, and gave them a direct interest in the management of the fund, so that they would watch and guard against accidents as far as possible.

Mr. E. W. T. Richmond said most of those present took great interest in the question under discussion, because it directly touched their pockets. There was a great deal of useful information contained in Mr. Keen's remarks; and, though his experience had been considerable, they were not bound to follow his conclusions. Mr. Webber—he was glad that so eminent an authority on a question of this kind was present—had said he considered the law a good one, and that it was calculated to do justice and right to the employers. Mr. Keen said it would widen the breach which already existed between capital and labour; but at the same time he expressed the opinion that he and his co-traders had been dealing more liberally with their employees than they would be compelled to do under the Act. If this were so, he (Mr. Richmond) failed to see why the breach would be widened. He thought the law was a good one, and that their fellow-men who had to run risks in working machinery, and in other ways, should have full and fair compensation guaranteed them. The great question they had to decide was how they were to cover themselves against the risk. He agreed that the wisest plan was to insure against fatal accidents at the lowest figure they could obtain, and take themselves the risk of minor accidents—at any rate, until sufficient data had been obtained to bring down to a proper level the exorbitant rates now offered.

Mr. J. P. Leather (Burnley) said he should like to add to what he said the previous day that, in the course of some years, the cost would come to about 6s. per cent., taking it under the new law; and that consequently the figure given in Mr. Ellery's paper was too small. On the other hand, the figures of 8s. to 10s. which Mr. Penney had obtained from some Insurance Companies, were not much out of the way.

Mr. J. Nasmith (Manchester) said it seemed to him that there were two or three factors entering into this matter which did not appear to have received due consideration. Though he believed strongly that the rates now being asked by Insurance Companies were far too high in proportion to the risk, it must not be forgotten that the Act was a novel one. It was a compromise between the old Employers' Liability Act and the system of insurance which prevailed on the Continent, particularly in Germany; and, in consequence of its being an attempt at a compromise, it contained a large number of doubtful points which could only be settled after considerable litigation. What employers would have to face during the next few years was not merely the claims for compensation, but also the risk of having to fight these disputed points from Court to Court, which would add greatly to the expense. Therefore, as a matter of prudence, if it were possible to insure at anything like reasonable cost, it would pay them all, at any rate for the first year or two, to put themselves under the protection of an Insurance Company. After that, the exact purport of certain clauses would be settled, and they would be able to form a true estimate of the risks, and ascertain approximately what it was going to cost them. The Insurance Companies were not so "stiff in the upper lip" as some people thought. He had had some experience in negotiating an insurance which started at 15s. and ended at 5s. He found even the tariff offices, with all their talk about the risk, were quite disposed to come down; and he thought they had made a very good bargain, and freed themselves from the risk of litigation, at a very reasonable rate. There was no doubt that under the Act, when everything except an accident caused by wilful and serious misconduct would be compensated for, there would be a little disposition to be more careless than before. He did not think many men were going to wilfully maim themselves—they were not such fools as that; but when a man knew that, whatever was the cause of the accident, he could claim something under the Act, in many cases there would be disposition to carelessness. It threw a duty on employers to see that this should not have any chance of encouragement. Having studied the Continental systems, it appeared to him that, if legislation of this kind were carried to its logical conclusion, it would have to come to some plan of compulsory State insurance. In Germany there was a system under which the State contributed towards the insurance fund, and the employers and workmen were also compelled to contribute; and thus the burden was spread over the whole area, and everybody had an interest in seeing that accidents were as far as possible prevented. If the Act were to have its logical conclusion, they might in some future Parliament find the gentleman from Birmingham, Sir John Gorst, or someone else, introducing a Bill on the lines of the German insurance. By the present Act, there was an enormous responsibility thrown on one class, while the class most directly benefited went scot free.

Mr. Keen said there was already in England a great deal too much stuff "made in Germany." The last speaker might have said that the cost in Germany had increased more than 50 per cent. since the system was started; and it was being seriously considered where it was going to end, and whether it would not be well to revise the whole scheme.

Mr. Isaac Carr (Widnes) said the point which was now exercising all their minds was what they ought to do for the present. He thought, after hearing the various speakers, that it would not be prudent to enter into any permanent arrangement this year; and he proposed to make the best temporary arrangement he could until the thing took more definite form. A very important meeting was to be held in London—the Mayor of Stoke-upon-Trent (Mr. F. Geen) having taken the initiative; and they might see what the outcome of it would be. Mr. Penney held out the hope that even a lower premium than 8s. per cent. might be accepted. The statement in Mr. Ellery's paper, giving the average for a number of works at 2s. 8d. was doubtless correct for those works, and might, as Mr. Leather had pointed out, be the minimum, whereas 6s. might be the maximum. If they struck the mean of the two prices, probably it would be about the average risk. He had no doubt the Council of the Institute would take the matter into immediate consideration, and if they could see their way, would be only too glad to do something in the direction of a joint insurance, probably combining in some way with the action already taken by the North of England Association.

The President, in closing the discussion, said he did not think he could add anything to the information already given. His Committee had not felt disposed to let anything pass out of their own hands. With the large number of men employed, they felt competent to meet any claim which might arise. One speaker only had touched upon the most objectionable portion of the scheme for going to Insurance Companies—viz., that it was to be their will whether one was to be brought into Court, and have all the trouble and anxiety of litigation, on the understanding that if he lost he would be paid in the end. They fortunately had had very little of this sort of thing to do in Belfast; for he never had any difficulty in making things right. He need not refer to the small works question, though they must all see that the same amount of money would have to be paid by the smallest works in the kingdom as by The Gaslight and Coke Company; so that he need not pursue this any further. The discussion had been almost a "record" one in regard to the number who had taken part in it; and Mr. Ellery would feel quite repaid for the trouble he had taken in preparing the paper. He (the President) only regretted that Mr. Ellery had not been able to join in the discussion; but his engagements rendered

this impossible. Under these circumstances, it had been suggested that Mr. Ellery should have an opportunity of replying in writing to the remarks of the various speakers before the time came for the "Transactions" to be issued to the members.

STANDARDIZING OF METER UNIONS.

By Robert S. Carlow, of Arbroath.

The subject which, as Secretary of the North British Association of Gas Managers, I have been requested to lay before you to-day, is one which has for several years past exercised the minds of the members of that body. Consideration and discussion of the proposal for standardizing meter unions originated through a paper read by Mr. J. Napier Myers, of Saltcoats, at the annual meeting of the Association held in Melrose in 1895. As the outcome of a lengthened discussion, which I shall briefly summarize, a remit was made to the Research Committee to bring the proposal under the notice of the Scottish meter makers, and endeavour to obtain their co-operation in carrying out what was considered by the Association to be an eminently desirable reform.

At the following year's meeting, the Research Committee presented their report, with a suggested standard set of screw gauges; and as the result, it was left with the Committee to correspond with the Standards Department of the Board of Trade, to endeavour to secure their approval of the set of gauges referred to. An effort was made to arrange a meeting with Mr. Chaney, of the Standards Department of the Board of Trade, but without success; and the Research Committee, at the annual meeting held last year, suggested that it should be remitted to them to consult with the Councils of The Gas Institute, the Institution of Gas Engineers, and kindred Associations, with the view of taking common action in the matter. This was agreed to, and duly carried out. From The Gas Institute, the reply was in the form of a suggestion that I should lay before the members at Belfast a full statement of all that had transpired at the North British Association meetings in reference to the subject. Accordingly, I have to ask your indulgence while I proceed to summarize the papers, reports, and discussions relative to the subject, which have appeared in the official reports of the meetings of the Association.

The author then proceeded to give a detailed account of what had been done in the matter of the North British Association, as noticed in our columns at the time of their annual meeting last year, and also referred to at various District Association meetings held this year. He concluded by saying: I desire to emphasize one point—that the North British Association, while so far committed to a particular set of unions, are animated by the desire only to secure the adoption of some such standard as shall meet the approval of all parties concerned. They have no wish to claim an exclusive preference for the unions which they have adopted, and which are now exhibited for the inspection of the members, but will heartily co-operate in bringing about uniformity, so that a constant source of trouble and annoyance to those engaged in the profession may be removed.

Stagg's Pressure and Exhaust Gauge.—At the Ulster Hall, Belfast, last week, there was shown, in connection with the exhibition of the Kern incandescent burner, a new form of pressure and exhaust gauge, as made by Messrs. Thomas Glover and Co., Limited, working under patent No. 29,318 of 1896. The inventor is Mr. W. Stagg, of Bristol; and an illustrated abstract of the patent specification was given in the "Journal" for Dec. 7, 1897 (p. 1237). The feature of the gauge is that there is only one glass tube, and the pressure is read off directly from the height of the water column against the scale, as in a thermometer. The scale is attached to a float, which rests upon the water contained in the casing. When the gas is turned on, the pressure forces the water down the casing and up the glass tube; and the sectional area of the casing being so much greater than that of the tube, it follows that it sinks very slightly compared with the rise of water in the glass tube. As the water sinks, it carries the scale down with it; and the water rising in the tube gives an exact and immediate reading of the pressure of the gas at all times. There was not an opportunity to test the gauge as against one of the ordinary construction; but by all accounts it is most reliable in its operation.

INSTITUTION OF GAS ENGINEERS.

PROCEEDINGS AT THE GENERAL MEETING,

HELD AT THE

ROYAL UNITED SERVICE INSTITUTION,

Whitehall, S.W.,

JUNE 14th and 15th, 1898.

Mr. G. E. Stevenson, M.Inst.C.E., President.

PAPERS AND DISCUSSIONS.

(*Continued from p.* 1460.)

THE PENTANE TEN-CANDLE STANDARD LAMP.

By Professor A. Vernon Harcourt.

The 10-candle standard lamp, of which the author has been asked to give an account, is the lineal descendant of two 1-candle lamps proposed by him many years ago, and has inherited features from both of them. The first of these lamps was shown and described at a meeting of The Gas Institute at Sheffield in 1883, and is figured in the "Transactions" of the Institute for that year.* In this lamp there was burnt a mixture of pentane vapour with air, formed by allowing air to enter a small reservoir of pentane at some height above the burner, and supplied thence by gravitation. Some of the heat needed for the volatilization was drawn from the lamp by means of a copper bracket attached to the base of the reservoir. The present ten-candle lamp resembles its predecessor in these two particulars.

A few years later, the author proposed another 1-candle lamp, having the same form of burner, with the addition of a cylindrical jacket surmounted by a cone to steady and brighten the flame, and with a metal chimney into which the flame entered at about ¾ inch. The gas burnt was the vapour of pentane raised by a wick to a point at which it was volatilized by the heat conducted downwards from the top. A very steady flame was thus obtained, of the form and size of a short piece of lead pencil, whose yield of light could be adjusted by setting the height of the chimney. The actual height of the flame (for observing which a small window was provided in the chimney) might vary, it was found, through 0·5 inch or more without affecting the brightness of the exposed portion.

There have been adopted from this small predecessor, in constructing the 10-candle lamp—(1) the plan of the outer jacket and cone for supplying warm air to the exterior of the flame; (2) that of a chimney fixed above the flame to steady it and at the same time to screen off the light of the upper and more variable part; and (3) that of a window in the chimney for observing the total height of the flame. Of these devices, the most important is the screening-off of the top of the flame; and for this the author is indebted to Mr. Dibdin and Mr. Sugg. Various improvements in the construction of the lamp, which has grown solely to its present form, are due to the mechanical knowledge and skill of the author's colleague, Mr. Vernon Boys; while in every detail its efficiency, and the agreement of one lamp with another, are the result of the excellent workmanship of Messrs. Chance and Co.

To obtain a steady and compact flame giving a light of 10 candles, it was necessary to adopt the principle of the argand burner; it was also desirable to make the lamp simple and portable. For these purposes the domestic lamp with a reservoir of oil (which might be pentane), a wick to raise the pentane to the point at which it would be volatilized by heat conducted downwards from the flame, and a glass chimney, first suggested itself. On the planning and making of such a lamp the author bestowed much time; and, having found experimentally the details of the con-

* See "Journal," Vol. XLI., p. 1143; also "Transactions" of The Gas Institute for 1883, where will be found descriptions of the table photometer, which has now been adopted by the Gas Referees, and of the aerorthometer; also *ante*, p. 1252.

struction which would produce a constant light of ten candles, he asked Messrs. Chance to make these lamps, and showed and described one of them to the Physical Section of the British Association in 1895. The principal difficulty which he encountered was that of so far commanding the evaporation of the pentane, when no influx of air was used to vary the tension of the vapour, so that the flame could be kept at the desired height, both when the room was hot and when it was cold. This difficulty was not perfectly overcome, and in consequence the lamp required too much watching and turning up or down. A fresh plan was tried. Two small pillars were placed on opposite sides of the reservoir of the lamp and opening into it. In these the pentane was raised by wicks above the level of the burner, whence the vapour flowed to the burner by gravitation, mixed with air which was admitted at the top of the pillars. By regulating the admission of air, the flame could be set at the desired height, and remained fairly constant. While this lamp was being worked out, further observations were being made with the 10-candle burner proposed by Mr. Dibdin. Unexpected irregularities were met with in a comparison of several of these burners one with another—not very large in amount, but rather too large to be neglected. As far as could be made out, the lack of agreement between the burners was due to differences in the glass cylinders placed round the flame.

In consequence of this experience, the author tried to devise an argand burner which would give a bright and steady flame without the use of a chimney to produce a current of air. The solid flame of the 1-candle burner needed only an external air-current, and this had been supplied by warming air within a cylinder capped by a cone at the base of the flame, and by drawing in air all round the upper part of the flame by means of a tube which the flame heated and entered. The cylindrical flame of an argand needs also an inner air-current. It occurred to the author that such a current might be produced by placing round the chimney-tube over the lamp a larger tube from which a branch might bend round and connect with the centre of the burner. The heated air would ascend, and then, losing its heat as it passed away from the chimney-tube, would descend, and would still be under a pressure rather greater than the atmospheric pressure when it entered the central chamber and passed up into the flame.

After various trials, it was found that a good flame could be thus produced; the chimney-tube serving also to cut off the variable light of the top of the flame. The requisite supply of pentane vapour was obtained, as in the first 1-candle lamp, by supporting a reservoir of pentane upon a bracket at the top of the lamp, and allowing air to circulate over a sufficient surface of the volatile liquid. It remained to discover experimentally what dimensions the parts of the lamp must have to give a flame whose total light was not much more than that of 10 candles. If the total light is much in excess of the portion of light desired, the flame is still bright when it passes behind the screen, and a small difference in the height of the screen materially affects the light shed horizontally. But if the flame immediately beneath the screen is dull, small variations in the adjustment of the height of the screen will not be material. In the present lamp, the distance between the surface of the burner and the bottom of the chimney-tube which screens off the top of the flame can easily be set to a quarter of a millimetre; but a variation of 1 mm. either way makes no measurable difference in the light. Even a variation of 2 mm. makes but little difference. The cause of this singular stability in the value of the light, whether the length of the exposed portion of the flame is 45 or 49 mm., is not only the relative dulness of the upper part, but that when the chimney is lowered the air-current impinges more strongly upon the central and most luminous part of the flame, thus compensating for its diminished length. A similar compensation, as Mr. Dibdin has pointed out, is the cause of the constancy of the light of the lower part of an argand flame when the consumption of gas varies, and the cut-off part of the flame is longer or shorter.

The construction of the present lamp will be much better understood from the detail drawings than from any further description. The triangle of blackened copper, which helps to support the shelf carrying the reservoir of pentane, assists also to dissipate the heat which the air-current brings, and which must be taken from it as early as possible on its descending way. For the same reason, the reservoir of pentane is so supported that heat will travel to it freely by conduction from the same point; the heat thus got rid of serving to promote the evaporation of the pentane. For setting the height of the chimney-tube, and placing it symmetrically over the burner, the author uses a solid cylinder of the right length, as in his second one-candle lamp.

When the lamp is to be used in a fixed position, it is best to support it upon a tripod with screw, swivel-plate, and clamp, as shown in the Notification of the Gas Referees for the present summer.* If the lamp has to be moved, the necessary stability may be given to its stand by providing three additional branches, which are used only to give support in the three directions in which any instrument resting on a tripod stand is most easily upset. The mode of using such a six-branched stand is to raise three alternate screws well above the table on which the stand rests, then to level by means of the other three screws, and finally to turn down the alternate screws, which are made to run easily, till the first increase of resistance shows that their tips are just touching the surface of the table.

Some account must be added of the manner in which the original lamp was adjusted to give a light of 10 candles, and of the evidence (1) that such lamps, as now manufactured by Messrs. Chance, give the same light one as another; (2) that this light is equal to that of 10 standard candles; and (3) that the ordinary variations in the pressure, temperature, and humidity of the atmosphere do not affect the ratio between the light of the lamp and that of the 1-candle pentane standard.

The size and brightness of the flame of the lamp depend upon the diameter of the burner, the space between the burner and the chimney-tube, and the outside and inside supply of air. Suitable dimensions for the burner, and for the chamber around it which produces the external air-current, had been found in constructing the two previous lamps to which reference has been made. The exact and final adjustment to a yield of 10 candles light was made by varying the height of the chimney-tube and those other parts of the construction which produce the internal air-current. After each small change, a comparison was made between the light of the lamp and the pentane unit; and according to the result further changes were made till the required yield of light was attained.

Table I. contains a summary of the experimental evidence showing that the four lamps which have been tested by the Gas Referees are exactly equal. Table II. gives the results of a comparison of two of the same lamps with the pentane 1-candle standard. It will be observed that the means of these testings, which extended over eight weeks, give the value of Lamp II. as 10·01, and that of Lamp III. as 9·99. The mean atmospheric pressure was 30·1 inches of mercury. At this and higher pressures, the mean value of the lamps was 10·03; at the lower pressures it was 9·97. Similar comparisons will show that the small differences in the testings day by day bear no constant relation, and are therefore not due to the variations of atmospheric temperature and humidity which occurred during this period in the room in which the testings were made.

TABLE I.

Comparison of Lamps.

Values of Lamp I.; the value of Lamp II. being taken as 10. Each number is the mean of five observations.

1897.	
Nov. 22	9·96, 9·95, 9·97, 9·99, 9·98, 10·05, 10·05, 9·95.
„ 23	10·00, 10 03, 10·01, 9·99, 10·01, 10·01, 10·04, 10 06.

Equally good results were obtained on other days, and when the lamps were compared on an open bar photometer instead of on the table photometer. The light of the two lamps was found to be still exactly equal when the top of the flame of one was set alternately so low as to be only just visible, and so high as nearly to touch the cross-bar of the talc window.

Values of Lamps I. and II.; the value of Lamp III. being taken as 10. Each number is the mean of ten observations.

1897. Dec. 14 and 15.	10·01, 10·04 10·08; 10·00, 10·02, 9·98, 10·00, 9 98.

Values of Lamp II.; the value of Lamp IV. being taken as 10. Each number is the mean of ten observations.

1898. April 12 and 21.	9·94, 9·96, 10·01; 10·00, 10·03, 9 99, 9·97, 9 99.

* See *ante*, p. 1258 (fig. 6).

TABLE II.—*Light of Pentane Lamp in Candles, as represented by the One-Candle Pentane Standard.*

Date. 1897.	Thermometers. Wet Bulb.	Thermometers. Dry Bulb	Barometer.	Light.	—
Oct. 11	13·5	15·0	29·75	10·04	Lamp II.
,, 12	12·4	14·0	29·80	9·94	,,
,, 20	15·0	16·5	30·35	10·04	,,
,, ,,	15·2	16·5	30·35	10·17	,,
,, 27	12·4	14·0	30·10	10·05	,,
,, ,,	13·0	14·4	30·10	9·96	,,
,, 28	12·4	13·6	30·05	9·95	,,
,, 29	13·0	14·5	29·90	9·93	,,
,, 30	13·1	14·6	29·96	10·00	,,
Nov. 1	13·0	14·2	30·17	10·07	,,
,, 2	12·2	14·0	30·10	9·96	,,
,, 3	12·0	13·8	30·09	10·00	,, Mean, 10·01
,, 11	11·8	13·2	30·00	10·00	Lamp III.
,, 12	12·5	13·9	29·73	9·93	,,
,, 13	13 8	14·8	29·50	9 94	,,
,, 15	11·9	13·4	29·95	10·04	,,
,, 17	12·9	14·0	29·93	10·00	,,
,, 18	12·6	13·9	30·13	10·00	,,
,, 20	12·1	13·4	30·48	10·09	,,
,, 22	12·3	13·8	30·44	10·05	,,
,, 24	11·5	13·0	30·20	9·95	,,
,, 26	11·2	13·0	30·15	10·02	,,
,, 27	11·8	13·0	29·83	9·975	,,
,, 29	10·4	12·2	29·45	9·925	,,
Dec. 1	10·5	12·0	29·30	9·875	,,
,, 2	11·0	12·6	30·05	10·06	,, Mean, 9·987

A TWO-CANDLE PENTANE STANDARD.

By E. LLEWELLYN PRYCE, of Birmingham.

In 1876, Professor Vernon Harcourt suggested the use of pentane as a means of obtaining a standard of light to take the place of sperm candles. All to whom accuracy in the measurement of light is an object are agreed that a more reliable standard than the sperm candle is required; and it is significant of the value of the proposal to use pentane that, with most of the practicable standards of light which have been devised in this country during the last twenty years, pentane has been employed. The fact that it is a liquid of definite composition, and one which can be readily obtained in large quantity in a sufficiently pure state for the purpose required, while, owing to its great vapour tension, it can, either with or without admixture of air, be burned in a gaseous condition, no doubt accounts for the preference it has received.

Professor Harcourt's pentane standard, introduced the following year, consists of a burner of very simple construction—viz., a brass tube 4 inches long and 1 inch in diameter, plugged with a brass disc $\frac{1}{2}$ inch thick, with a $\frac{1}{4}$-inch orifice in the centre at which the pentane gas is burned. A horizontal platinum wire is fixed over the burner at a height of 63·5 mm., or $2\frac{1}{2}$ inches.

Air carburetted with pentane, in the proportion of 1 cubic foot of air at standard temperature and pressure to 3 cubic inches of pentane, sp. gr. ·62 to ·63, when supplied to the burner at the rate of half a cubic foot per hour, gave a flame $2\frac{1}{2}$ inches high and possessing an illuminating value of 1 candle. It was found that the maintenance of the $2\frac{1}{2}$-inch flame was most important; since, although small differences in the composition of the pentane, or errors made in preparing the pentane gas, affected the rate at which it had to be burned to maintain the $2\frac{1}{2}$-inch flame, the amount of light given by such flame was of almost constant value.

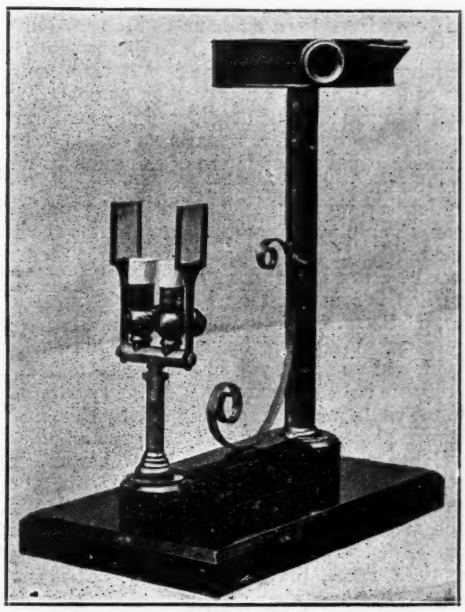
In 1883, Professor Harcourt produced a portable pentane lamp, with which the burner previously described was used; but the gasholder for storing the pentane gas and the meter for registering its consumption—necessary when using the earlier standard—were no longer required; and, as the Simmance 2-candle standard is a modification of this portable pentane lamp, the following description of the latter by Professor Harcourt is given:—

It will be seen that the flame is still an air-gas flame, produced by mixing in the reservoir of the lamp the vapour of pentane with air. The mixture, being heavier than air, floats over the liquid; its composition varying in each layer, from a very rich gas, at the surface of the pentane, to air into which little or no pentane has diffused, beneath the lid. It is clear that by tapping this stratified mixture of gases at the proper level, an air gas containing three volumes of air to one of pentane—the same that is made up in the gasholder—may be drawn off; the same mixture being constantly produced at the same level, by evaporation and diffusion of pentane vapour from below and inflow of air from above. The rate of flow of the gas depends upon the height of the pipe within the reservoir above the top of the burner, the size of the hole drilled through a plug which blocks the pipe at one point, and the density of the mixed gases.

Any three of the four quantities above named being kept constant, the fourth will be constant. Thus the dimensions of the pipe and hole having been fixed, if the density of the gas is constant, the rate of flow will be constant; and equally—and this is the principle of the lamp—if the rate of flow is kept constant by setting the height of the flame, the mixture will be the same. The permanent adjustment of the length of pipe and size of hole was made by repeated trials, until the flame of the lamp gave exactly as much light as the standard flame. This having been done, similar lamps can readily be produced by measurement.

The height abov e the surface of the pentane at which the standard gas is to be drawn off varies with the temperature, and therefore needs to be adjusted on each occasion and from time to time. It is convenient to have the means of making this adjustment without exposing the eyes to more light than falls upon them when observing (through a hole in a screen) whether the tip of the flame touches the wire above. The arrangement for this purpose consists of an india-rubber ball filled with water, and connected by a flexible tube with the bottom of the reservoir.

By pressing upon the ball with a screw, the water can be raised to any required level in the reservoir; the pentane, supplied drop by drop at about the rate at which it is consumed, floats on the surface of the water. So much heat is absorbed by the evaporation of the pentane, that a constant supply of heat is necessary. Such a constant supply is readily obtained by fastening to the reservoir a stout copper wire, which supports a copper disc over the flame. The height and inclination of the disc above the flame may be altered from time to time according to the temperature of the room in which the lamp is used. A glass T, which connects with the reservoir the supplies of water and of pentane, serves also as a gauge to tell the height of the liquids within the reservoir. A stopcock and bulb beneath the T serve to shut in and keep the small quantity of pentane which is in the reservoir at the end of a testing. A glass collar beneath the burner, and another beneath the reservoir, serve to prevent the conduction of heat along the brass tube.



SIMMANCE'S TWO-CANDLE PENTANE STANDARD.

As will be seen from the diagram, the 2-candle pentane standard is of very simple construction. The burners consist of steatite tubes, each fitted at the top with a brass plug 1 inch in diameter, through the centre of which a hole $\frac{1}{4}$-inch in diameter has been drilled. Each burner has a stopcock, by means of which the height of the flame can be regulated; and as the burners can thus be used independently, the standard may be employed as a 1-candle standard if it be required. Two blue-glass screens are provided, with cross wires fixed at a height of 50 mm. from the top of the burners; and when the flames are maintained at this height, they each possess an illuminating power of one candle.

The carburetter is circular, and is used about half filled with pentane. It is fitted with a spiral plate, attached to the top of the interior, but not reaching the bottom. This spiral is so fixed that air entering the opening at the side of the carburetter pursues a spiral course over the surface of the pentane, and becomes completely saturated with its vapour. On reaching the centre of the vessel, the carburetted air flows down the tube leading to the burners. The simplicity of the apparatus is greatly in its favour. No glass chimneys, by the use of which errors have been introduced into other standards, are used. Neither is a gasholder required to force air over the surface of the pentane, since it is drawn into the

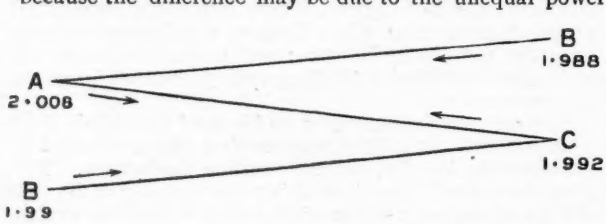
carburetter automatically by reason of the fall of the heavy carburetted air down the tube leading to the burners. The apparatus employed with the Harcourt lamp for obtaining a mixture of air and pentane of definite composition is not required, because air completely saturated with pentane vapour is burned. Moreover, the whole of the flame is used (no cut-off screens being employed), which is an advantage if the standard is to form part of a photometer having a travelling disc-box, as is usually the case in this country.

To use the standard, the plug at the side of the carburetter is removed, and the carburetter half filled with pentane. The burner-cocks are then opened, and a light applied. After the lamp has been alight for about five minutes, little difficulty will be experienced in maintaining the flames at the required height, although, perhaps, they are not quite so stable as could be wished.

The author regrets that, owing to the shortness of time at his disposal, a thorough investigation of the reliability of these standards under varied conditions could not be made. It would, for example, have been interesting to know what alteration, if any, in the light-value of this standard occurs with change of temperature, since there can be but little doubt that, in a hot photometer-room, the air in its passage to the burner would take up a larger proportion of pentane than it could in a cold room. The effect of barometric changes is also deserving of attention. It is not believed, however, that any serious alteration in the value of the standard can be due to any of these causes. Experiments have been made as to the variability of the standards among themselves, since this appears to be the first inquiry which should be made, although an investigation as to the value of a standard as compared with that at present in use may be considered of equal importance. If, however, a proposed new standard could not be exactly reproduced so that all made are of the same value, further work with it would be useless.

In order to compare these standards, the method of substitution, as employed by the Committee on the Proposed Standard of Light and Temperature of Gas Measurement, appointed by the Institution, has been adopted; and, as this method is somewhat unusual in photometric investigations, a short description of it may not be regarded as unnecessary. Weighing by substitution has long been practised, and no doubt was of great service in those days when reliable balances were with difficulty obtained. If it was required to weigh 1 oz. of gold by this method, the weight was placed upon one of the pans of the balance, and weights and small shot upon the other until the 1-oz. weight was exactly counterpoised. This weight was then removed, and gold substituted until equilibrium was once more obtained. It will readily be seen that, even if the balance be defective, so that the counterpoise weighs more or less than 1 oz., the weight of the gold cannot but be correct, since it has taken the place of the 1-oz. weight.

In testing standards of light by the method of substitution, if three be used, say A, B, and C (of course, there is no limit to the number), A is placed at one end of the photometer-bar, 30 inches from the centre, and B at the other at an equal distance from the centre. After the lamps have been alight for about ten minutes, the height of the flames is adjusted, and a number of readings are taken. As an example, it may be found that the value of B compared with A is as 1·96 to 2; but it does not necessarily follow that B is actually of less value than A because the difference may be due to the unequal power



of the observer's eyes, to the reflection of light in the photometer-room, or to other causes which have escaped notice. B is then removed, and standard C put in its place. Should this also possess value as compared with A of 1·96 to 2, it must follow that B and C are of precisely the same value. A and B may now be compared, and the relative value of all three standards accurately determined.

Compared in this way, the following results, which show a very close agreement, have been obtained with three of the 2-candle standards, two of which were kindly lent by Messrs. Alexander Wright and Co., Limited.

If B be taken as possessing an illuminating value of two candles, the value of

$$A = \frac{2 \times 2{\cdot}008}{1{\cdot}99} = 2{\cdot}018 \text{ candles};$$

and the value of

$$C = \frac{2 \times 1{\cdot}992}{1{\cdot}988} = 2{\cdot}004 \text{ candles.}$$

Other determinations have given

B = 2·000 candles.	B = 2·000 candles.
A = 2·004 ,,	A = 2·024 ,,
C = 1·996 ,,	C = 2·018 ,,

The average being

B = 2·000 candles.
A = 2·015 ,,
C = 2·006 ,,

Three standards have therefore been constructed which are practically of equal value; and there should be no difficulty in making others to agree with them.

Standard B has been employed to determine the illuminating power of coal gas supplied from one of the holders at the Birmingham works simultaneously with the use of the Methven standard and also with standard sperm candles; but, up to the present, a sufficient number of tests have not been made to warrant the author bringing them before this meeting. The average of the results obtained so far, however, shows a very close agreement between the 2-candle standard, the Methven, and also the candles. The 2-candle pentane standard is recommended for use in experimental researches, for which the present candle standard is quite unsuited.

So much has already been said about the unreliability of the standard sperm candle, that further comment is useless. The experimental error, it has been authoritatively stated, may amount to no less than 20 per cent. An error of 10 per cent. is not unusual; while errors of 5 or 6 per cent. are frequently obtained. It is most important, therefore, that in scientific work, where accuracy is especially required, a less variable standard should be employed. It would be difficult to conceive the position which the chemical industries of this country would now hold had the chemical balance been of such defective construction that experimental errors in weighing of as much as 20 per cent. were possible; but, knowing how much depends upon the accuracy of this instrument, one would not be far wrong in saying that it must have been comparatively insignificant. Although the photometer is not of such predominant importance to the gasmaker as the balance is to the chemist, it cannot but be that the interests of the former—whose primary object is the production of light—have suffered on account of the inefficiency of his standard of measurement; though probably it will not be generally recognized how great an incumbrance this has been, until some time has elapsed after the introduction of a less variable standard. It will not be going too far to say that some new methods of manufacture, and modifications of plant, by which increased illuminating value is said to be gained, have been received with a certain amount of scepticism which probably would not have obtained had the means of measuring illuminating power been more exact. Others, perhaps, would never have been introduced. Reference may also be made to the state of confusion which now exists as regards the value of various enriching materials, since the very diverse statements as to their value are probably more due to photometrical causes than to differences in purity of material or mode of applying it.

The author therefore recommends the abandonment of standard sperm candles, and the substitution of the 2-candle pentane standard, which, so far as his experience has extended, appears to be one of the simplest and most reliable yet devised.

Discussion.

The PRESIDENT said these were two very interesting papers, and the members must be specially impressed with the great pains which Professor Harcourt had taken, not only to perfect his 10-candle standard, which was now adopted by the Gas Referees, but to explain it in so lucid a manner. Of course, it was now impossible that the

2-candle standard should be adopted, inasmuch as the 10-candle standard had been determined upon; but it did not detract from the usefulness of the former standard for practical purposes.

Mr. FRANK LIVESEY (London) said all must agree that thanks were due to Professor Harcourt for the immense amount of time and thought he had given to the subject before the meeting. The matter must now be considered settled. The great point was that there was now no glass chimney, which was shown, not only by Mr. Harcourt, but by the Institution Committee, to be a great difficulty. It always had to be turned in the same position towards the disc, if equal results were to be obtained. Of course, chimneys were not everlasting. When one was broken, another had to be substituted; and there was no certainty that the second would be like the first. The Committee had agreed—perhaps it was owing to the chimney—that the burner could not be reproduced in quantities alike. There did not seem to be the same difficulty about this instrument; and, as gas makers, they were pleased to find that this standard came nearer to the 10 candles than did Mr. Dibdin's. Mr. Dibdin's 10-candle lamp gave a value—some said of 10¾, and certainly 10½ candles. He always liked the 1-candle lamp of Mr. Harcourt, having used it very often, and found it reliable. This also had no chimney; and the top of the flame was cut off. There was every reason to hope the new lamp would be a success, and would not be subject to the difficulties which Mr. Harcourt found with a previous lamp, one of which was that at high temperatures (above 70°) it was almost impossible to prevent it smoking.

Mr. H. E. JONES (London) said he was very pleased to hear that Mr. Livesey had tested the 10-candle standard, and found it free from the excess of illuminating value which he (Mr. Jones) always experienced with the Dibdin 10-candle standard. Although he had signed the report approving of that standard in the Dibdin form, he did it with the reservation that the mode of testing should not involve burning exactly 5 cubic feet of gas, no matter what might be the constitution of the gas; and that part of the report he considered compensated in some measure for the defect of the standard, which, according to all the tests made in the Commercial Gas Company's laboratory, was at least 2 per cent. above the average candle of that day. The opinion had been expressed that that candle was not so good as the one of 1875, when the existing legislation for London was passed, fixing the illuminating power, and deciding on the "London" argand burner. However this might be, they had all the way through had the Methven standard to go by; and he never could find that the candle of the day had deteriorated as compared with that of 1875. He had always found the Methven standard most reliable, and certainly most satisfactory for daily use in gas-works. He noticed by the report of the Committee that they agreed with the view that the Dibdin standard was at least 2 per cent. above the normal candle; and he could quite corroborate this from some independent experiments made at the time. He agreed with Mr. Hunt's view that they should fill the chimney with flame, and get the best result they could for the gas which they were burning, and then correct for the volume required, rather than burn exactly 5 cubic feet. He should also like to speak in praise of the table photometer, which was now notified to the London County Council as the one to be adopted. The advantage of being able with both eyes to see the shadows of both flames on the same surface was inestimable. He had never been able—perhaps owing to defective sight—to reconcile the exact illumination of the screen with the candle at one end of the photometer and the gas-light at the other. There always seemed such a difference of colour given by the flames as to vitiate the power of equalizing the illumination on both sides. In the table photometer, they had the advantage of seeing upon the ground glass the shadow cast by both flames, and could judge with one eye or with both, as they pleased, and this gave them a very delicate power of adjusting the balance of illumination.

Mr. CHARLES HUNT (Birmingham) said they were much indebted to the authors of both the papers before them, though, not unnaturally, their interest centred especially in that of Mr. Harcourt and the 10-candle standard, which appeared likely to be the standard of the future. Mr. Harcourt had given an excellent *résumé* of the gradual development of the burner, and had dealt very fairly with the objections attributable to the chimney which had been pointed out by the late Mr. Methven and others after the Board of Trade Committee had completed their researches. He was glad to hear that Mr. Frank Livesey was of opinion that the value of the proposed standard was equal to 10 candles.

Mr. LIVESEY remarked that what he said was that it was a nearer approach to it.

Mr. HUNT said it seemed likely to be accepted as a 10-candle standard. The abolition of the chimney raised another question—namely, the possible effect of the chimney on the gas, when under test. He was inclined to think that this might next have to occupy the attention of the Referees. It appeared that they had the power to substitute this standard for the candles, and also to vary the rate of consumption of the gas. If he were not out of order in referring to the recent Notification of the Gas Referees, and Mr. Harcourt would not mind answering one or two questions with regard thereto, he should like to ask, in the first place, how the height of the argand burner above the table had been arrived at. He noticed that it was fixed at something under 14 inches. Now, in some experiments made recently with a certain form of photometer, they found that the height of the flame above the table exercised an important influence on the illuminating power of the gas. With the flame only 11 inches above the table, there was a difference against the gas of about ¾-candle, as compared with what it was at 18 inches; showing that the air supplied to the burner required very careful attention, as otherwise the illuminating power was likely to be depreciated. Another point arising out of the Instructions was with regard to the limitation of the flame to 16-candle illumination. He was glad to notice that, even in a limited sense, what he had consistently advocated with regard to the rate of consumption had been recognized. But supposing they were supplying only 15-candle gas, was the arrangement of the photometer to be varied to agree with this quality? On the other hand, if they were supplying 17-candle gas, was the photometer in that case to be varied? If so, then a different photometer would have to be constructed for each quality of gas, unless it could be arranged to vary the distance on the table for each quality of gas. At the same time, if it was right to raise the illuminating power to 17 candles, why was it not right, once for all, to record the illuminating power of the flame when being consumed to the best advantage in the burner, and adjust accordingly? Suppose, for example, 17 candles were fixed as the maximum illuminating power to be given by the standard burner, then the photometer need only be adjusted to 17 candles. This would be a universal photometer for use whenever the standard argand was applied for testing purposes; and the gas would everywhere be tested under similar conditions. This would fully meet the views he had often expressed, that the gas should be burnt to the best advantage in the burner; and he should be glad to know if Mr. Harcourt had any objection to this being done.

Mr. T. S. LACEY (Pimlico) said he had tested various 10-candle standards, with the object of seeing what would be the effect of any individual chimney that might be abnormal. With an abnormal chimney on the Dibdin burner, and another on the "London" argand, he had found differences of 5 per cent. from the results given with normal chimneys on both burners. He hoped, therefore, that some means might be adopted to prevent the continuous use of an abnormal chimney on the burner. The problem of comparing different flames such as these standard flames was a very difficult one, for the reason that they were comparing things which were really not constant, but were continually moving up and down. They might take two 10-candle standards which agreed; but the absolute light coming from each would be found to vary considerably. The candle value of the flames could not be determined by the use of the standards only, and he had himself adopted the method, which he thought a little novel, of having a good secondary battery and an electric lamp. This gave a very constant light. The burners lost or gained light according to atmospheric conditions. The pentane standard was more sensitive than the "London" argand; and, consequently, under less favourable conditions, the pentane gave out less light. But he ventured to think that if the argand flame was of the same character as the 10-candle flame, in all probability the variations would be more nearly equal in both, and the

atmospheric conditions would not affect the result in the same way. They had not yet arrived at a standard which gave a definite amount of light at all times; and when such a standard was found, he did not think it would be a flame standard. It seemed to him that this standard would answer their purpose very well. The absence of a chimney was a very great point in its favour, and made it preferable to the Dibdin standard, besides being nearer 10 candles than the Dibdin standard had on several occasions been found to be.

Dr. H. G. Colman (Saltley, Birmingham) said he should like to add his thanks to Mr. Harcourt for having given them the pentane standard, which was likely to be of uniform value, whether it was exactly 10 candles or not. With candles, they could not rely on their own tests; and still less could they rely on those of other people. But if they got this standard, they would be able to compare results, and know better what they were doing. He had not been able to make experiments with the actual standard, and could not say anything as to its being exactly of 10-candle value. There were one or two points about the 2-candle standard of Mr. Simmance which he should like to mention. He had had it in use at Saltley for the last eight or nine months, and the tests so far had been most satisfactory. When he first saw it, he was rather afraid there would be some difficulty in regulating the height to 50 mm., and keeping it regular; but he found in practice, even in a room not free from draughts, that there was really no difficulty whatever about this. He was also rather surprised at seeing that a slight variation in the height of the flame made so slight a difference in the results. A difference of $\frac{1}{64}$ inch was very perceptible; but if they had both flames $\frac{1}{64}$ inch too low or too high, it really made very little difference. Altogether, the apparatus was more easy to handle than he expected. The results of the tests made at various times—first with candles, and then with this 2-candle standard—came out, on an average, extremely close. There were variations from day to day between the two; but the average came out within 0·05 of a candle, and if he rejected one or two tests where the candles manifestly did not burn properly, the average difference was only something like 0·02 candle. If the 10-candle standard were adopted universally, there would be no field for the 2-candle one for official purposes; but at the same time it would be very useful on the works, for making coal tests and similar purposes. In many works it could well be employed in place of the Methven screen, which had done splendid service, but was affected by the chimney in the same way as the Dibdin standard. With different chimneys, one could get with the same Methven screen, and testing the same gas, a variation of 2 to 3 per cent.; and though the screen was much more reliable than candles, the apparatus of Mr. Simmance was a further improvement upon it. Another objection to the Methven screen at the present time was the general introduction of carburetted water gas. Where this gas was used, it was absolutely impossible to employ uncarburetted gas in the screen, because it gave much too low results; and, as far as his own experience went, if this gas were carburetted with pentane, the screen would give considerably greater variations than was the case when using ordinary coal gas of from 16 to 17 candle power. Whether this was due to the fact that the difference caused by variations in the chimney was greater when the short wide slot was used in place of the long narrow one, he could not definitely say; but he thought this was probable. Mr. Simmance's standard was very simple to work; the only point necessary to look after being the level of the pentane in the carburetter. It should not be allowed to fall too low, but should be kept as nearly as possible half full. If it fell too low, the results on the illuminating power were rather too high. Another improvement which might be made would be to replace the plug, which had to be removed from the carburetter before lighting the flames, by a stopcock, as in Mr. Harcourt's apparatus. With regard to the question of the table photometer, they had found, like Mr. Hunt, that a free air supply to the argand burner made a considerable difference in the illuminating power of the gas, and that in many photometers the argand burner was too close to the table, or the screens were too close to the argand, which limited the air supply, and gave a considerably lower result. If the screens were removed, they at once got with the same gas a much higher illuminating power. He saw there would be no difficulty in arranging the table photometer for testing other than 16-candle gas, by varying the distance of the argand burner from the screen; but in testing water gas, if this form were used, it would be necessary to make some alteration. This, of course, would be only for their own purposes; and they would not be bound by any statutory obligations. Testing carburetted water gas by the table photometer, as prescribed by the Referees, using a 16-candle flame, would tell largely against the gas. If ordinary water gas, from 18 to 21 candle power, were tested in an argand burner, it was better to keep the height of the flame such that it gave a light of about 18 candles. If the table photometer was universally adopted for the purpose of statutory tests, it would be necessary, when testing carburetted water gas, or when making tests of cannel gas, to modify it in the manner he had indicated. It would, however, be well to continue for these purposes the use of the bar photometer; and in this case the 2-candle standard would be found of immense use.

Mr. J. W. Helps (Croydon) said he had had a little experience with the 2-candle standard mentioned by Mr. Pryce, and had found it of great use on the works. Though it was true that the 10-candle standard was now legalized, and the 2-candle lamp could not therefore be employed for any purpose under statutory obligations, there were many purposes for which such a standard was very useful. As the last speaker had said, it would be particularly valuable in testing carburetted water gas, as he himself had proved. Where one had to make practically throughout the 24 hours a continued series of tests, candles were naturally very difficult to deal with; and, as had been said, the Methven screen was out of the question. The point where he thought he should find most difficulty in connection with this standard was the shaking of the light in the position in which they had placed it. The testing-room at Croydon was immediately over the water-gas engine-room; and naturally the floor was subject to a good deal of shaking. He must say, however, that he was surprised to find that, even under these adverse circumstances, he had no difficulty in regulating the flame, and keeping it practically steady. He had not made sufficient experiments to allow of his speaking definitely as to its accuracy with respect to candles; but he was satisfied that at Croydon they obtained practically the same results.

Mr. C. Vernon Boys said he was not in a position to add very much to the present discussion. Naturally, what he had had to do in this matter had been very small in amount. As was generally known, he was recently appointed a Gas Referee; being nominated at a time when the question of the standard was a serious matter of discussion. At that period Mr. Harcourt had finished, or nearly finished, the experiments which led to the designing of the lamp now on the table. In the official capacity in which he found himself, he felt it important (independently of anything he had done before) to assure himself as to the light given by the lamp. He did not like to use the expression 10 candles, because, so far as his short experience went, he did not know what a candle was. He had before him the report of the Standards Committee; and he found what was common knowledge—that the candle itself was a perfectly untrustworthy standard of light. He also learnt that the simple and beautiful 1-candle burner which he had known for many years was accepted generally, although not universally, as a fair measure of a candle, and also that this was the only means at disposal by which to examine candles, and see if they were up to the mark, and might fairly be considered standard candles. Tests he made, therefore, were necessarily tests, not against candles, but against the 1-candle standard. He did not know how many tests he had made, for photometry was an exceedingly tedious and aggravating kind of occupation; but he spent an enormous amount of time at the end of last year and the beginning of this. He also made some experiments at Oxford, and satisfied himself that the 10-candle lamp was an exceedingly accurate multiple of the 1-candle standard. In this sense, therefore, his official conscience was entirely satisfied. In the second place, taking the report of the Committee as one which ought to be followed, he felt that the Referees were not departing from its spirit. It was true that the Dibdin standard itself was not the one which had been finally adopted, but a standard which contained the good points of the Dibdin, and was free from those sources of either trouble or inaccuracy which it was to the general convenience to avoid. He was not going to make any attack

on the Dibdin standard, which he imagined was the most perfect thing of the kind at the time; but that was no reason why anything believed to be more perfect should not be adopted. The chimney he did not refer to, as it had been already sufficiently dealt with by speakers. Turning, however, to the gas-testing place, there was not always too much room. Convenience was a point which should not be lost sight of; and a lamp in which it was not necessary to provide any means for forcing an extra supply of air, had a definite practical advantage. Further, there was the point that a lamp in which the design of the parts upon which the exact measure of the luminosity depended was not too complicated and minute, but in which all the forms were those which could be readily and accurately described by reference to a drawing, and easily produced with accuracy in a workshop, was a form which should be adopted in preference to one in which perhaps the lamp did rather better in the way of getting more light from a given amount of fuel, but in which minute curves and small holes and forms which were not so easily and accurately reproduced, were found. This weighed very strongly with him in forming the independent conclusion that this was another point on which this lamp had some advantage over its somewhat similar analogue, the Dibdin standard. He had not had the advantage of being present when Mr. Harcourt was speaking; but he had seen the proof of his paper, and there was one passage there to which he must take some exception. The author had referred to him as being in some way instrumental in assisting in the development of the lamp. This was not literally true. The lamp as they saw it that day, in every essential feature, came ready to his hand. He had done nothing to improve it, and had only made one or two minor suggestions of a merely constructional character—such as making a screw stronger. He must disclaim all credit for the design of the lamp, though at the same time he did not wish to disclaim his full share of responsibility in having accepted it. He was perfectly certain that his choice was a good one, and that the lamp was one of very great merit; and he must express his great admiration at the result, and his appreciation of the labours of Mr. Harcourt in producing this standard. With regard to the table photometer, the details of it had occupied a great deal of his attention lately; and the feature of it, as prescribed and defined in the Notification, was intended—and he hoped would be found—to carry the idea of extreme simplicity and freedom from useless expenditure. There was nothing there which they believed expensive or difficult to make. Everything had been done with a view to obtaining accuracy without expense, and efficiency without unnecessary trouble.

Mr. W. Foulis (Glasgow) said they were all indebted to Mr. Harcourt for the labour he had bestowed in producing this beautiful standard; but he (Mr. Foulis) wished to ask whether the table photometer just referred to was universally applicable for all qualities of gas, and if not, how it could be made applicable. He was about to order a table photometer; but, after reading the instructions for its use, he found this difficulty: In Glasgow they tested their gas, which was 20-candle, in a flat-flame burner consuming 5 cubic feet per hour; and if the quantity of gas burnt was reduced so as to give a light equal to 16 candles, he certainly should not get anything like the relative quality of his gas. What he wished to know was whether the table photometer could, without alteration, be adapted to testing any quality of gas.

Mr. R. O. Paterson (Cheltenham) desired to thank Mr. Harcourt for the kindness with which he had come forward at his invitation and prepared his paper. He (Mr. Paterson) had the pleasure on the previous day of seeing the instrument in operation, and working with it; and he could only say that the 10-candle standard lamp, in connection with the table photometer which the Referees had introduced, gave such facilities for testing gas as really called for admiration. There was no doubt at all that it was a photometer and a standard specially suited for 16-candle gas; and he could only speak of it in this connection. The facility with which the standard lamp could be dealt with was also a point on which he had some little experience. It was readily adaptable in the hands of anyone, without the slightest difficulty. As to whether or not it was actually of the value of 10 candles, he would say nothing. He had a difficulty with a lamp he obtained from the manufacturers, with which he had been experimenting before the Referees issued their Instructions. This lamp, in his hands, was not satisfactory, in the sense that it was not a multiple of one candle; but as soon as the Referees' Instructions were issued giving the dimensions of the instrument, he examined it, and found that it was not properly set—the distance of the chimney from the top of the burner being considerably less than the prescribed height. When he discovered this, he returned the lamp to the makers, and was sorry he had not been able to get it back again previous to the meeting. There was no doubt that a 10-candle flame could be obtained simply, as Mr. Harcourt had pointed out, by the regulation of the distance between the top of the burner and the bottom of the chimney.

Mr. J. West (Manchester) said some years ago, at one of the first meetings in connection with the consideration of the new standard of light, he pointed out that very many years previously, in conjunction with their old friend Mr. Hartley, he made a large number of experiments on the pentane lamp; and at that time they found it gave more light than a standard sperm candle. He was pleased to find that Mr. Harcourt had brought his 10-candle lamp more nearly to the proper candle power than it was originally. This had been accepted by Mr. Frank Livesey and others; and it therefore might be looked upon as a more reliable standard than they were previously inclined to think. In setting up any new standard, they should certainly have one of the same value as formerly; and much as candles had been abused, he thought that in a good operator's hands, one could get a greater degree of accuracy with them than some had expressed. He had not himself found the divergence which had at times been spoken of. Though he was not one of those who adhered to the old candle if a better standard could be found, they must not forget that the standard decided upon would have to go all over the country; and, while it might be very well in the hands of some of their eminent friends in London, who had chemists to assist them in manipulating their apparatus, there were provincial towns and small works where something as simple as possible was required. It struck him, while Mr. Harcourt was describing the instrument, how difficult it might be to get accurate tests in some of these small works. The fact of the temperature being of great importance was one which might lead to difficulty. He understood that as the gas descended the tube, it must not be overheated, or the desired accuracy would not be obtained; and though Mr. Harcourt, with his sensitive touch, could tell degrees of temperature from the top to the bottom, some of the hardy "sons of toil" possessed hands which would not be of the same velvet texture as his own. He should, therefore, suggest that something more definite was required. There might be a thermometer at the bottom, or, at any rate, something more definite than the touch of various individuals, which might vary as much as the optics of some gas testers.

Mr. W. King (Liverpool) asked whether the flame of a batswing burner was affected to the same extent by atmospheric and other conditions as the flame of an ordinary argand burner with a glass chimney. In Liverpool, they had, he said, to supply gas of not less than 20-candle power in a batswing burner; and the standard which had been in use there for many years was Sugg's No. 7 steatite batswing—a well-known burner which was used in London for testing when cannel gas was being manufactured. Their experience had certainly not been such as that of many gentlemen who had spoken. In the paper, reference was made to the enormous differences arising from the use of candles—as much as 10, 15, and even 20 per cent. in various experiments. This was entirely beyond their experience in testing gas of 20-candle power with a flat-flame burner. They had not found practically these great differences in using candles; and he might throw out the idea, to which a previous speaker had alluded, whether these differences might not arise from the chimney of the argand burner rather than from the candles themselves. Like Mr. West, they were not entirely satisfied with the candles; but they did not think they were so black as they were painted. If they could use a perfectly reliable standard, they would all be only too glad to adopt it. These remarks were rather borne out by some figures which he thought might be interesting. The Corporation of Liverpool continually tested their gas—he might say hostilely, if it was understood that he did not use the word in any offensive sense. At any rate, it was an unbiassed test. Taking the results of their experiments—some

thousands during the twelve months—they came out on an average 20·77 candles. The Corporation Gas Examiner, in his last annual report, stated that 299 tests made at their office averaged 20·87 candles, and 91 tests taken at various points throughout the district, covering many miles of area, gave a figure of 20·68 candles. These averages were obtained from results having a very narrow range. The figures agreed remarkably with their own, and did not seem to point to the use of an unreliable standard. He had the details of the 91 tests; and in no case was the figure below 20. These figures might throw some light on the subject of using a flat-flame burner without a chimney; and it would be interesting to know whether any other gentleman had carried out tests with the bare flame—thus eliminating errors which might arise from differences in the thickness or obscurity of the chimney, or variations in the draught.

The PRESIDENT remarked that much of what Mr. King had said was in his own mind, though he did not intend to occupy time by talking about it. The conditions of testing in Manchester were very similar to Mr. King's, but were not, perhaps, so strictly watched over by a *quasi*-hostile Corporation. He strongly inclined to the idea that with the use of flat-flame burners much of the discrepancy found to exist in testing with the argand burner and low-power gas disappeared. Perhaps it was as well that the candle should be superseded, seeing that so many imperfections had been attributed to it; and whether the case had been exaggerated or not, it had become somewhat discredited. He was afraid that a great many of the imperfections of operators were charged to the discredit of the candle—at any rate, there was the temptation to do this; and perhaps it was as well to have a standard which could not equivocate, so that if things went wrong it would not be the fault of the standard, but of the tester or the gas. He found that with 20-candle gas consisting of gas made from coal mixed with that produced from cannel, to get the illuminating power required, it was much more difficult to maintain the candle power at any one uniform point than to get uniform testings of it. If they could be sure that the gas was always up to 20 candles, the candles in testing would certainly give a near enough result.

Mr. VERNON HARCOURT, in reply, thanked the members for the interest they had shown in his communication. He was glad to hear Mr. Frank Livesey's approval of the pentane standard, and Mr. Jones's experience of the table photometer. In answer to Mr. Hunt, he thought it likely that a burner near the surface of a table—perhaps when as much as 6 inches above it—would be less freely supplied with air than if supported at a higher level; but the height of 400 mm., or nearly 16 inches, adopted by the Gas Referees, he thought quite sufficient. Mr. Hunt and Mr. Foulis had inquired as to the applicability of the table photometer to the testing of gas of an illuminative value greater than 16 candles. Such gas could not be tested under the condition of a consumption of 5 cubic feet per hour by means of the "London" argand, but could be tested with this burner at a lower rate of consumption, on the principle now adopted of setting the light at 16 candles, and measuring the consumption. It could also be tested with the flat-flame burner, which was used at present, when giving a light of 20 or any other prescribed number of candles, by putting the burner some inches farther back. The fixed distance between the photoped, or illuminated surface, and the "London" argand in the present table photometer was 1265 mm.; if a burner giving a light of 20 candles were substituted, the corresponding distance would be 1414 mm., or nearly 6 inches more. It would also be possible to use the table with a 20-candle burner, in the place of the 16-candle burner, by bringing the standard lamp nearer to the photoped. But it seemed best to keep as the standard illumination with which others were to be compared, that produced by a light of 10 candles at the distance of 1000 mm.

Mr. FOULIS asked if the same table of corrections which accompanied the Instructions would serve for both gases.

Mr. HARCOURT replied that a similar table for 20-candle gas could be easily calculated.

Mr. HUNT asked if there would be any objection to testing 16-candle gas with an illumination of 17 candles in the chimney.

Mr. HARCOURT said he saw no advantage in doing so.

Mr. HUNT asked if there would be any objection, if there were no advantage.

Mr. HARCOURT replied that, according to the Metropolitan Gas Acts, the gas supplied had to be such as to produce, when consumed at the rate of 5 cubic feet per hour in the prescribed burner, a light equal in intensity to the light produced by 16 candles. With such gas they had to compare the gas actually supplied, which might be of slightly higher or of slightly lower illuminative value. The comparison could be made either by consuming gas at the prescribed rate and measuring the light, or by varying the quantity of gas burnt till the prescribed intensity of light was attained, and measuring the rate of consumption. Mr. Hunt's proposal was to fix neither rate of consumption nor intensity of light, but to measure both when the chimney was quite full of flame. A figure could thus be obtained for the illuminative value of the gas; but it was not certain, nor even probable, that if gas agreeing exactly with the definition of 16-candle gas given in the Acts were thus tested its illuminative value would be found to be 16 candles. Mr. West had referred to some experiments, in which he took part long ago with Mr. Hartley, in which they found that there was a want of stability in the 1-candle pentane standard, and that its light was rather greater than that of one candle. He believed the lack of stability was chiefly in the floor of the room in which the testings were made. He thought it likely that the 1-candle flame, as tested by Mr. Hartley, and even as used at one time by Mr. Dibdin, had given a light rather greater than that of the average standard candle. In the account of the table photometer read to The Gas Institute in 1883, he said that the height of the standard flame was to be adjusted by looking at its tip only and the wire above through a small opening in the curtain. If the tester, instead of thus screening from his sight the body of the flame, looked at the whole of it, he would see as definite a tip as in the other case; but it would not be the same tip, and he would set the flame higher, and get from it between 2 and 3 per cent. more light. Mr. West had expressed a doubt as to whether fingers accustomed to rough work, to which the manipulations of photometry might have to be entrusted at gas-works, would be sensitive to small gradations of temperature. In constructing and modifying the 10-candle lamp, it had been necessary to observe the effect of different means for cooling the tube through which the heated air descended. But no such observations were needed, nor any particular delicacy of touch, in the ordinary use of the lamp. Mr. King had referred to the results of a number of testings of gas supplied in Liverpool, in which candles had been used. The illuminative value was never below 20 candles. If the result was the average of a large number of candle testings, such uniformity was not surprising.

Mr. KING explained that his point was not that the averages were so nearly the same, but that there were only slight variations in the individual tests.

Mr. HARCOURT thought that for this to be so the testings must have been made very carefully, and that the actual value of the gas must have been much above 20 candles. It was now generally admitted that trustworthy estimates of the value of gas could not be obtained from three or four testings with candles. He was glad to hear that testings at the works and in various parts of the district had given similar results. He thought Mr. King's figures proved only the skill of the tester and the uniformly excellent quality of Liverpool gas. In conclusion, he thanked the members for the kind reception he had met with.

Mr. PRYCE also thanked the meeting for the kind way in which they had received his paper—the first which he had had the honour of reading before the Institution. He had mentioned that the flames of the standard were liable to waver a little; but this did not cause any difficulty in using it, for the moment after the wavering took place the readings would be found to be exactly the same as those previously made. As was well known, this was very different in the case of candle flames—a disturbance causing them to give increased luminosity; so that, notwithstanding the correction for consumption of sperm, at the end of the test the opposed light was returned of lower value than it would have been had such disturbance not occurred. He agreed with Dr. Colman in recommending the 2-candle standard in the place of the Methven burner, though he did so with some reluctance, on account of the good service the Methven screen had rendered them. He had used it for many years, and it had saved him an enormous amount of time; but the glass chimney caused

difficulties. He should like to point out incidentally that it was Mr. W. C. Young, who, in 1891, in a paper he read before the Society of Chemical Industry* first called attention to the irregularities which might take place by the use of chimneys with argand burners. He was able to say that improvements would be made in the 2-candle standard which would render it even more serviceable. It was proposed to bring down from the carburetters to the burners two tubes instead of one, and also to place cocks close under the carburetter for adjusting the quantity of pentane used. This would keep the flame much steadier than it was at present.

A NEW DEPARTURE IN CARBONIZING,

HAVING FOR ITS OBJECTS THE PREVENTION OF NAPHTHALENE TROUBLES, AND THE PROVIDING OF CHEAP ENRICHMENT.

By SAMUEL GLOVER, of St. Helens, and THOMAS GLOVER, of West Bromwich.

In the manufacture and distribution of coal gas for lighting purposes, there has been a little modest pride on the part of gas engineers in the knowledge that the article they supplied might always be relied upon when wanted, and that the price per unit of light was low as compared with its competitors. In spite of the fact that gas has hitherto been the cheapest source of artificial light when used with modern burners, strenuous efforts are constantly being made to reduce the cost of manufacture. This being so not only where, under the sliding-scale, the possibility of paying improved dividends acts as a healthy stimulant, but also under municipal ownership, where no such stimulant exists.

The efforts made for the cheapening of production have assumed various forms, among which may be mentioned (1) the introduction of machinery in the carbonizing department, and the use of small coal; (2) the application of higher temperatures to the retorts, whereby a larger volume of gas is obtained from a given weight of coal; and (3) improved methods of separating the tar from the gas.

On works where machinery has been installed, it is usually considered unnecessary to use round coal, which before being used must be broken; and the tendency has been to purchase a class of coal which in the days of uneconomical gas-making would have been considered quite unsuitable. Moreover, the practice of using cannel coal for enrichment has been gradually discontinued; its place having been taken by various substitutes, such as the volatile hydrocarbon vapours obtained from petroleum spirit, oil gas, or carburetted water gas. These modern developments have had a marked effect upon the cost of production and the selling price of gas; but, unfortunately, the old quality of reliability has been somewhat interfered with, owing to an excessive production of naphthalene, the inconveniences arising from which are only too well known to most of us.

To overcome the difficulties arising from the use of higher heats and cheaper coals, it was necessary at the St. Helens works to use a high percentage of cannel; but as this was found to be an expensive and inconvenient method of enrichment, the Engineer was led to look round for a substitute for cannel, and this he believed he had found in the Peebles process for producing oil gas. That process was adopted at St. Helens in the full belief that it not only produced the cheapest enrichment, but also under the then popular impression that the rich oil gas would dissolve and hold in diffusion through the coal gas the vapour of naphthalene, which was liable to give trouble.

As was stated in a former communication to this Institution by one of the authors,† the practical working of the Peebles process fully bore out all his anticipations so far as the cheapness of enrichment was concerned; and when enrichment could be obtained at such a low cost, it led to inquiries being made for still cheaper coals to produce the bulk of gas at a low rate. The supply was found from some of the slacks in his district. By using these slacks, carefully selected for their coke-making qualities, and enriching the poor quality gas with Peebles oil gas, he has been able to manufacture and deliver into the holder 18·5-candle gas at an average price of something under 7d. per 1000 cubic feet, inclusive of all manufacturing charges. In thus obtaining the cheap gas, however, he found, after a time, that he had to contend with difficulties which he had not anticipated. Owing to the fineness of the slack coal, and the high temperature employed to carbonize it, there was so much naphthalene produced that the gas was left so heavily charged with this compound as to give a gradually increasing amount of trouble from stopped services.

Careful investigation and research proved that, while the Peebles oil gas was by far the cheapest form of enrichment, the popular idea that the rich hydrocarbon oil gas had the power of holding the naphthalene of the coal gas in diffusion, and preventing its deposition in the crystalline form, was altogether erroneous. It was also found that, to have any effect upon the naphthalene, it is absolutely essential that the solvent for it should either be in the liquid form, or, if present in the gas in the form of vapour, that its vapour tension should be similar to that of the naphthalene, so as to condense along with and carry it away in solution. It became evident that the use of cannel had performed other functions in addition to that of enriching, and that it had also acted as a solvent, and removed part of the naphthalene from the coal gas during the process of condensation; thus modifying the troubles attendant upon its deposition.

The knowledge of these conditions led the Engineer to join with his colleagues in devising a simple and convenient process for the prevention of naphthalene deposits, the application of which would not involve a reversion to uneconomical methods of manufacture. The aim of the present paper is to give some account of the process adopted, and the measure of success which has been attained.

The principles upon which the process is based have already been fully explained in a paper communicated to a kindred Association,* and therefore it is unnecessary to go again into their details. It may, however, be desirable to briefly recapitulate their main features.

Coals, when carbonized at low temperatures, have their constituent elements arranged into products very different from those obtained from the same coals distilled at high temperatures. At the low temperatures, the hydrocarbon products present are mainly those belonging to the paraffin and olefine series, together with the largest possible quantity of basic and acid hydrocarbons and the minimum quantity of gas. As the temperature of carbonization rises, these low-temperature products are broken up and re-arranged to form more stable products belonging to the benzol, naphthalene, and anthracene series, until, at the higher temperatures employed for the economical production of gas, the paraffin and olefines are present in comparatively trifling quantities, while the naphthalene is so abundant as to practically saturate the small volume of tars and the large volume of poor coal gas, and there is an absence of the necessary solvents for naphthalene in the form of vapours in the gas. The true causes of the trouble from naphthalene were thus concluded to be due to the lack of liquid hydrocarbons present in the products capable of dissolving the naphthalene out of the gas, and preventing its being deposited in the solid crystalline form.

Cannel coal, from its nature, even when distilled at high temperatures, yields a quantity of the hydrocarbons suitable to absorb naphthalene or prevent its deposition in the crystalline form. But to employ cannel and condense the products along with those from the coal involves loss, owing to the tars taking up in solution the hydrocarbons which should be left in the gas to act as solvents and enrichers. Furthermore, in consequence of the presence of the large quantity of naphthalene, the power of the cannel products to absorb that remaining in the gas is to a large extent nullified.

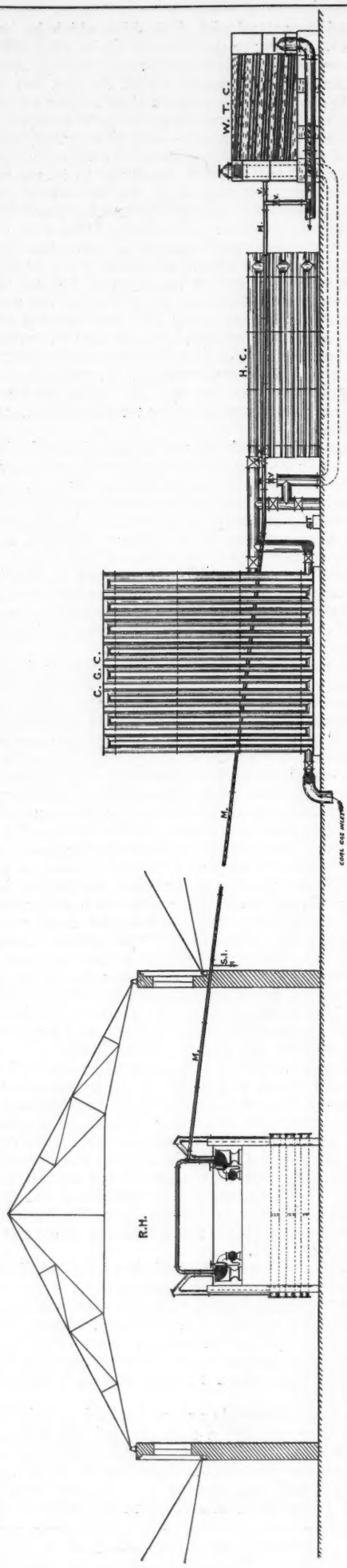
These observations suggested to us the application of the solvent and carburetting hydrocarbons to the coal gas after it has been condensed, when the tars, with the major portion of the naphthalene, have been removed, and it is therefore in a condition for the solvents employed to act on the remaining naphthalene, and for carrying in diffusion the hydrocarbons suited for enrichment, when they are presented to it.

Seeing that when coals are carbonized at suitable temperatures they produce a rich gas, and also hydrocarbon products comparatively free from naphthalene, and suitable for performing the double function of dissolving the naphthalene and carburetting the gas, we were led to anticipate (from the results obtained by carbonizing oil at

* See "JOURNAL," Vol. LVII., p. 249. † *Ibid.*, Vol. LXIII., p. 1050.

* See "JOURNAL," Vol. LXX., p. 16.

THE MODIFIED ARRANGEMENT OF PEEBLES PLANT AT THE ST. HELENS GAS-WORKS.



M. Main for conveying products from low-temperature retorts. V. Valves for regulating admission of low-temperature products to coal gas. C.G.C. Coal-Gas Condenser. H.C. Horizontal Condenser. S.I. Steam inlet.
W.T.C. Water-tube condenser. S.T. Steam-trap. R.H. Retort-house.

comparatively low temperatures by the Peebles process) that a good practical method of obtaining the necessary products would be to carbonize the cannel at a low temperature, and use the resulting products to treat the condensed coal gas, so as to free it from naphthalene and to carburet it.

To test the correctness of those principles, some preliminary experiments were tried at the West Bromwich Gas-Works; and the results obtained led to a more complete trial being made at the St. Helens works, the apparatus being arranged as shown on the diagram here given, which illustrates the way in which the apparatus was connected up for the purpose of carrying out the process.

The setting of retorts devoted to the work of low-temperature distillation is one in a bench of fifteen settings of seven through retorts 20 feet long. The retorts in this setting have been made into "singles" by means of a stop built into the centre. Each bed is fitted with separate hydraulic mains, which are connected to the foul main by means of suitable valves. The valves of the bed experimented with having been closed, a special take-off pipe has been fitted to the hydraulic main to convey the products away while still hot.

The products of the lower temperature distillation are thus isolated, and are kept from cooling by means of a steam-pipe laid inside the main. Those sufficiently volatile are maintained in the state of vapours; while other products, somewhat heavier, are kept in a fine state of subdivision in the gas. The products are all mixed with the large volume of condensed coal gas into which they are diffused. The naphthalene still remaining in the coal gas is acted upon in the manner previously described, and the gas is at the same time enriched. If we take into consideration the enormous comparative volume of this high-temperature coal gas, which, being unsaturated, is in a sense thirsting for these vapours, it can easily be conceived that it will be in a condition to take up, and carry in diffusion, a large quantity of the vapours from the low-temperature products.

The connections were completed on Dec. 31, 1897, and the result of the first three months' working was that the naphthalene complaints were reduced to less than one-third of what they had been during the previous three months, although, with the varying nature of the weather, the circumstances were certainly more favourable to the deposition of naphthalene; and all the evidence goes to prove that the previously deposited naphthalene is gradually being picked up by the gas as now made, and cleared out of the distributing system, whereas trouble was experienced throughout the whole of last year.

The percentage of cannel carbonized in the setting devoted to its treatment was 6 per cent. of the total coals used at the time of starting; and this gradually increased, as the settings using coal were reduced, until in April it was 10 per cent. This was found to be giving sufficient enrichment to raise the high-temperature coal gas from 15·5 candles to 19·01 candles; this being an average of 22 tests. The production of gas per ton has not suffered to any material extent through the introduction of the new system; being 10,296 cubic feet per ton of coal carbonized. These results, compared with working in the old way, show a saving of upwards of 50 per cent. on the cannel; previous experience showing that, even with higher-class coal, 25 to 30 per cent. of cannel had been required to obtain equal results, all other conditions being the same.

By the results obtained in the working of this process, the cost of gas into the holder has been still further reduced. The process therefore provides a remedy for naphthalene troubles and the cheapest form of enrichment; but where enrichment is unnecessary, the principles of the process can be applied as a remedy for naphthalene. In such cases ordinary coal would be used to supply cheaply and conveniently the necessary solvents. It should be noted that the average quality of the tar by the new process is not interfered with; being, in fact, better for producing anthracene and benzols than that derived from a mixture of coal and cannel when used in the ordinary way.

It now remains to give a rational explanation as to how these results are realized, founded upon well-ascertained chemical and physical facts.

Many years ago, it was demonstrated by Mr. William Young, at a meeting of the North British Association of Gas Managers, that equal quantities of carbon and of

hydrogen, when combined as hydrocarbon gases, or hydrocarbons and free hydrogen, and having varying molecular structures, would give widely different illuminating powers. The combinations as paraffins were shown to have the least intrinsic illuminating powers; and as the carbon and hydrogen were re-arranged into the high-temperature products, such as olefines, benzols, and acetylene, both the illuminating power and the volume were increased. It was pointed out that each rise in volume and illuminating power was accompanied by a greater amount of heat-energy being stored up in the molecules of the carbon and hydrogen; and it was surmised that the increased illuminating power was probably due to this stored-up energy being liberated as light, at the instant of decomposition in the luminous flame.

Subsequently, in May, 1884, Professor Percy F. Frankland, in a communication to the Society of Chemical Industry, showed that olefiant gas, when diffused in certain proportions through non-luminous hydrogen, had its intrinsic luminosity greatly increased; and when a mixture of olefiant gas and marsh gas was made, the intrinsic value of the olefiant gas was increased to a still greater extent.

More recently, Professor Lewes has shown that acetylene—a gas having stored up in its molecules a large amount of heat-energy, and having an extremely high intrinsic illuminating power—loses enormously in its illuminating power when diffused through certain proportions of hydrogen, marsh gas, or coal gas.

The probable explanation of these phenomena may be that the low-temperature products of destructive distillation—the paraffins and olefines—having a low stored-up heat-energy in their molecules, take up further heat from the gases through which they are diffused, during the early stages of combustion. The store of heat thus absorbed is given out again as light at the instant of decomposition of the more complex molecules. On the other hand, acetylene, having the largest possible stored-up heat-energy, cannot absorb heat from the surrounding gases, but, on the contrary, has, at the instant of decomposition, to part with a portion of its stored-up heat to the diluting gases through which it is diffused. It thereby has its illuminating power reduced. Whatever be the cause, there is no doubt about the facts; and it is thus evident that the constitution of an enriching gas has a considerable influence on the enriching effect which may be obtained.

Perhaps the best practical evidence on this point is supplied by the Peebles process, where the oil is subjected to destructive distillation at comparatively low temperatures, and where the main products in the resulting gas are paraffins and olefines. It is well known that oil gas so produced, when diffused through coal gas, has its intrinsic illuminating value practically doubled. On the other hand, oil gas produced at high temperatures has for its principal constituents, members of the benzol and acetylene groups of hydrocarbons. Such a gas, when used as an enriching agent diffused through coal gas, would have its intrinsic illuminating power only slightly increased. The same condition holds good in the carbonizing of coals and cannels; the gases and hydrocarbon vapours produced at low temperatures having a much higher enriching value than gases made from similar coals at high temperatures, due to causes already explained.

These facts have only come to our knowledge in recent years, through the introduction and the practical employment of high and low temperature products as enriching agents. Up till quite recently, it was understood that gases having different illuminating powers would, when mixed, yield a mean illuminating power of the gases employed. While the high enrichment obtained by this process is thus shown to be mainly due to the difference in the constitution of the gases and the volatile hydrocarbon products resulting from the carbonization of coal and cannel at temperatures suited to the object in view, there is also a considerable gain in enrichment value from the method of condensation employed.

The attention of the gas industry was drawn to the principles involved in condensation more than thirty years ago by the Rev. W. R. Bowditch, M.A., F.C.S., and more particularly to the influence and solvent action of low-tensioned products upon the more volatile vapours, and the loss in the illuminating power, due to this solvent action, which ensued. He also pointed out that the power of the heavier hydrocarbons to dissolve out the lighter was dependent upon the temperature during the time the heavy vapours were separating out from the gas. The principle was laid down by him that it was desirable to precipitate the thick tar from the gas while still hot, and thus prevent the absorption of valuable illuminating constituents.

These have been the guiding principles of the industry since that time; and they have been applied in many modern works, to a limited extent, in a number of ways, with beneficial results for the most part, but accompanied by the drawback that, owing to the removal of the tar at an early stage from the foul mains, it cannot exercise its solvent action upon the naphthalene of the gas. The large amount of this constituent present in gas made at high temperatures has thus less chance of being absorbed.

The new method of treating the products explained in this paper allows of the correct principles being thoroughly applied, and the full value of both the high and low temperature products obtained, with the additional advantage that a sufficient supply of solvents is provided for dealing effectually with the naphthalene.

It is only necessary now to add a few words in further explanation of that part of the process which deals with the prevention of naphthalene deposits. For information on the subject of the influence of the temperature of carbonization on the gaseous and liquid products, the study of the following communications may be commended: "Studies in Coal Distillation," by Mr. Lewis T. Wright, Society of Chemical Industry, London, 1888; "Coal Gas," in Thorpe's "Dictionary of Applied Chemistry;" also a communication by Mr. Watson Smith to the Society of Chemical Industry in 1889. In his paper communicated to the Society of Chemical Industry, Mr. L. T. Wright gives detailed analyses of the tars resulting from the carbonization of coals at different temperatures. From these it will be seen that tars from low-temperature distillation were perfectly fluid, owing to the freedom from naphthalene, and that they contain a large percentage of hydrocarbons suitable for acting as solvents for naphthalene.

As the temperature of carbonization rises, however, the character of the tar changes until distillates are yielded which are almost solid with naphthalene, and contain only a very small percentage which would act as naphthalene solvents; there being practically a gap in the series of distillates as compared with those yielded by tar from the low-temperature distillation. To fill up this gap, and provide enough solvents for naphthalene, it would be necessary, with the ordinary arrangement of plant, to use a large proportion of cannel coal; but this is undesirable for many and obvious reasons. By the process described in this paper, sufficient solvents are produced by the use of a small percentage of cannel, or even by ordinary coal; and from the way in which these solvents are applied their effect is most powerful.

It has already been shown that the remedy can not only be applied without adding to the cost of the manufacture, but that an actual saving is possible over present methods. It is hoped that the explanation thus offered of the interesting results obtained will be acceptable to the members of the Institution; and it is the firm conviction of the authors that, wherever the process is tried, considerable benefit will be experienced.

Discussion.

The PRESIDENT said the paper had a peculiar interest, as dealing with new ideas as to how coal and cannel should be carbonized. Though many might be of opinion that some of the theoretical explanations were open to criticism, it was a great step for anyone to take to make a practical experiment of the kind, and bring forward the results as Mr. Glover had done. He had visited Mr. Glover's works at St. Helens, for the purpose of viewing the process; and he was extremely pleased with the thorough way in which the experiment was carried out. In fact, it was more than an experiment, for the process had been carried on for four months—since last December; and he appeared to have commenced in a tentative way while still using the Peebles oil process. He found this method of carbonizing enabled him to get better illuminating power, and he gradually dispensed with it; and at the time of his (Mr. Stevenson's) visit, the Peebles process was no longer in use. An equal illuminating power to that formerly produced by it was obtained by this method alone, using a far smaller percentage of cannel than was formerly found necessary.

Mr. A. F. BROWNE (Rotherhithe) said it appeared to him

that the authors of the paper were to be congratulated on having made a considerable addition to their knowledge as to the best method of employing cannel most economically, where it was the agent employed for gas enrichment. They claimed to get from one ton of cannel the same effect as was obtained before from two tons. This was a very startling statement; but the result, he understood, was brought about in two ways—first, by carbonizing the cannel at a low temperature; and, secondly, by leading the cannel gas away from the influence of the tar upon the hydrocarbons which it contained during the process of condensation. In those parts of the country where a large percentage of cannel was used, it would appear scarcely possible that this idea of carbonizing cannel in special retorts at a special temperature had not been tried before; and he should be surprised to hear that Messrs. Glover were the first who had done so. Nevertheless, he believed they were the first to have taken the step of freeing it from the deleterious action of the tar. This seemed to point to the fact that they were on safe ground adopting means for the removal of tar from the gas during condensation. But, as the authors further showed, this very fact was likely to bring about an additional quantity of naphthalene in the gas after condensation, because having been less in contact with the tar the naphthalene was not dissolved out. These figures were so surprising that one felt it more than likely, if such a process were adopted, cannel might, temporarily at all events, be found to be the cheapest enricher; and they would all agree that a more cheaply, and a more easily applied method of using cannel could not be suggested. Passing to the question of naphthalene, perhaps many would still hold their judgment in suspense with regard to the theory put forward, though it appeared to be a very complete and intelligible one. He was sure the authors would not feel hurt if he alluded to the fact that they were supported in their conclusions by such a high authority as Mr. Young. Nevertheless, he thought there were some who were not quite prepared to accept the statement that the only way to get rid of naphthalene troubles was to dissolve the naphthalene out of the gas. Among the older generation of gas managers, it was a desideratum as far as possible to retain the naphthalene vapour in the gas, under the impression that it added to the luminosity. Now they were told that, in order to get rid of the naphthalene nuisance, they must dissolve out the naphthalene. After all, it was a question of £ *s. d.* If these results should be confirmed by other persons at other places, the authors would deserve well of the gas industry. Still, there did seem to be other means of getting rid of the naphthalene nuisance. Only yesterday he asked a member if he rightly understood him to say that in introducing water gas he found a marked influence on the naphthalene in his district. He said it was so when using a special brand of oil; but when he changed the oil, the effect was not so good. This seemed evidence against the view of Messrs. Glover, that it was useless to attempt to keep naphthalene in suspension by means of vapours diffused through coal gas or water gas. He should like to call attention to the fact that the point where the cannel gas was introduced in the condensing plant was about that where Mr. Shadbolt for one, and himself for another, had found singular effects to follow the return of coal gas (washed and scrubbed) to the condensing plant, or the introduction of petroleum vapours. Mr. Shadbolt found an increase of luminosity; and in some experiments of his own a few years ago he found that by adding small quantities of hydrocarbons or petroleum vapours at such points, he obtained a remarkable result. He was, therefore, not quite persuaded that the naphthalene was dissolved entirely and deposited from the gas. However, if a cheap and easy method had been discovered of getting rid of the naphthalene, he was inclined to think that the value of the naphthalene which could be retained in the gas, as contributing to luminosity, was not nearly so great as the amount of money which could be saved by avoiding nuisance in the district. Therefore, they could do nothing but congratulate the authors on the good results which had attended their efforts, and wish them every success in a further trial of the system. He believed Mr. Botley was still satisfied with the effect of the addition of oil mist in retaining the naphthalene in gas.

Mr. S. GLOVER said they did not claim to be the first to carbonize cannel at low temperatures or in separate retorts. As a matter of fact, they had carbonized just the same percentage of cannel in separate retorts at the same low temperature, and admitted it into the foul main in the same way through the valve attached to the hydraulic main, and obtained no observable results. What they claimed was that it was not only the carbonizing of the cannel at a low temperature, but the method in which the coal gas was treated before the cannel products were admitted to it. It was this which brought about the results that Mr. Browne declared to be so wonderful, and which he hardly believed himself until after months of observation. But there was no uncertainty about it; there was no dodging about. They always obtained from the process, since it was started, certain results. The certainty was obtained by very simple methods: They admitted to the coal gas a percentage of gas free from naphthalene, and so diluted the naphthalene-charged gas with gas having no naphthalene in it, which, therefore, perhaps carried forward with more certainty the naphthalene still remaining in the coal gas. They did not claim that they had washed out of the gas the whole of the naphthalene.

Mr. C. E. BOTLEY (Hastings) said a few remarks from him might be of interest, because last year, in conjunction with his son, he had the honour of reading a paper on the question now raised; and although the paper was rather complex, there were certain theories advanced which experience tended to show were likely to be realized in future. Now another year had passed, these theories had been amply proved; and he was happy to acknowledge that Messrs. Glover confirmed them. There was nothing he could take exception to. The only thing he could criticize was the means of arriving at the same result. It was a question of cost and position with regard to the coal used, and the quality of gas one had to supply; and indirectly the question of enrichment came in. It did not come very prominently forward; but there was no question that oil gas, as made by the Peebles process, or the excellent system Mr. Foulis used at Glasgow, had a very high value as an enricher. As had been pointed out, the illuminating value of oil gas was greatly in excess of its real value; but with carburetted water gas, this was not so. If one made high-quality gas, so far from getting the relative value, in many cases one had less.

The PRESIDENT did not think that could be accepted.

Mr. BOTLEY said it was so in many instances. He was speaking of 24 or 25 candle gas, which did not compare in enriching value, when mixed with ordinary 14-candle gas, with oil gas made by the Peebles process. This had been proved by experiment. At Hastings, they were a 15-candle Company. At St. Helens, Mr. Glover was able, with ordinary coal, to get 15½-candle gas; and he should be very happy if he could get coal of the same description in the South at a reasonable price.

Mr. S. GLOVER said he ought to have said 15-candle, not 15½-candle gas.

Mr. BOTLEY said the quality of the gas to begin with made a great deal of difference in what one required to add. He was surprised that any difficulty should have been found from naphthalene with coal giving a value of that kind, added to which they were using the Peebles process, which had an effect on the naphthalene in manufacture. But the Peebles process was not a deterrent of naphthalene in distribution. He knew several cases in which the process was operated; and the naphthalene trouble was as prominent as where coal and cannel were employed. At Hastings, he was quite aware that cannel was one of the best solvents for naphthalene. If sufficient could be used, one would to a great extent do away with the trouble; but under the old process, it would be necessary to have the illuminating power so high that it would give the consumers a better quality than they required, or was desirable. In connection with this, he had bye-passed gas from cannel coal made in separate retorts into the foul main, and then into the condenser, for the purpose of clearing it from naphthalene deposits. During this time, they had found a greater enrichment value in the gas. At Hastings, they were in this dilemma: They had used the same description of coal with no variation for twenty years—two descriptions of Newcastle coal—and all this time the naphthalene difficulty had been an increasing one. They went on for years, until at last it was difficult to keep things going with the number of blow-outs, and things of that kind; and therefore investigations were made. They found the popular idea that certain hydrocarbon oils introduced would have an effect on the naphthalene, was erroneous; and therefore they

went into the process described last year, which was hit on almost accidentally, but the success of which was undoubted, as he then stated. Starting with 1895, when not only the mains but all the services were completely stopped up, they had for a long time to use an excess of oil for misting or fogging the gas, not only to keep the naphthalene in the gas, but to dissolve the naphthalene there was in the mains and services; and therefore at first they oversaturated the gas so much that at certain positions they could detect faint traces of oil on the fittings. This was done for the purpose he had mentioned. But after a time a reduction was made in the oil, as it was found that they had cleared the whole of the mains and services from naphthalene, and therefore reduced the amount of oil which was fogged, and only put in sufficient to keep the pipes clear. In 1893, their stoppages were 13·55 a day; in 1894, 11·41; and in 1895, 19·52. In this year the process was introduced towards the autumn. Next year—viz., in 1896—the stoppages were reduced to 4·55, without any alteration in carbonizing, or in coal; and in 1897, they were reduced to 2·10 a day. This year, up to date, they were 1·32. There had been a great increase in the gas consumption, so that practically, whereas in 1893 they had a stoppage for each 1000 cubic feet of gas sold of 0·0153, in 1897 they only had 0·00209; and whereas in 1893 they had one stoppage throughout the year to every consumer, during last year they only had one for every ten consumers. This, of course, was very satisfactory; and 75 per cent. of the stoppages this year were due to other causes than naphthalene. With regard to the remainder, there was an uncertainty about them; and all this advantage was obtained without any perceptible increase of cost. In fact, the cost of the process at Hastings was so small that they need not be concerned. In the first year, it was 2½d. a ton, when they were oversaturating the gas; last year it worked out to 1d. a ton, or 0·028d. (oil only) for every 1000 cubic feet of gas sold. There was one remark made by Mr. Glover which absolutely confirmed what he said, that the volume of oil misting required to prevent the deposition of naphthalene was very small. He had pointed out that the quantity of cannel gas introduced into the bulk of coal gas was small, and would be about equal in proportion to the quantity of oil mist they were putting in at Hastings for the purpose of maintaining the gas in its normal condition. It had been said that they used carburetted water gas at Hastings; but last year, owing to a variety of causes, and making a number of experiments during the whole of the year, the quantity of water gas was less than 8 per cent. During this time, they used Newcastle coal and curley cannel to the extent of 1·82 per cent., to maintain an illuminating power of 15¾ candles. This being the case, carburetted water gas could have practically no influence on the question of naphthalene; for it was not in use for eight months in the year. Practically the oil employed was 1 gallon to envelope 166,000 cubic feet of gas; showing what a small volume was required. With regard to carburetted water gas, where it was used largely, and made in the ordinary way, it was possible that the same effect would be produced as by using an oil mist. Carburetted water gas, if examined, would be shown to possess an oily humidity, whereas coal gas had a watery humidity; and therefore the one prevented the other from depositing the naphthalene. He had been trying tests with regard to humidity in carburetted water gas; and in spite of every precaution, there was still a humidity after it had gone through all the processes of washing and purification, and had gone into distribution. This might be accounted for by the way in which it was made. It was rushed through the condenser in such a condition that there was not sufficient time-contact. It had been stated that in other places in the South using similar coal to himself, the naphthalene trouble was unknown; but he could only say from his experience that if they were able to avoid it altogether without any effort, they were extremely lucky.

Mr. J. W. Helps (Croydon), after congratulating Messrs. Glover on their very interesting paper, said he should not attempt to criticize it, except to make one remark with regard to the cost. He had asked Mr. Glover whether he had made any calculation as to the actual cost of enrichment of his gas, as he was now doing it, compared with the cost when using the Peebles process; and he told him that it came out practically cheaper. He stated in the paper that he was able to get gas of 18½ candles using half the quantity of cannel that he formerly did. Now he (Mr. Helps) found it cost him about 1¾d. per candle per 1000 cubic feet to enrich with cannel; and if he was able to reduce the quantity by half, it would then cost him something like ⅞d. At present, in Croydon, they were enriching with water gas; and he felt confident it was not costing anything like so much. Mr. Botley made an interesting statement with regard to the effect on naphthalene deposits of the process in operation at Hastings; and he stated that there were some places in the South where it was claimed that, by the use of water gas (with almost identical coals to those he employed), they were able to do away with naphthalene, and probably he referred to Croydon as one of those places.

Mr. Botley said he did not do so. He spoke of places where they did not use carburetted water gas.

Mr. Helps said there was no subject on which there was such a diversity of opinion as that of naphthalene. During the five months they had been using water gas, they had been practically without any trouble from stoppages due to naphthalene. One point which might be of interest was this: In Croydon, the photometers which were at the gas-works and the one at the testing-station some mile and a half away, generally gave very similar results. When it was 15·5 candles at the works, they got 15·3 candles, or something like that, at the Katharine Street station. During the last three or four months, they had been getting results at the Katharine Street office on an average showing half a candle higher than at the works where the gas was made. Naturally anybody would imagine that this would be accounted for by the fact that the gas enriched by the carburetted water gas was able to take up old deposits of naphthalene in the town, and carry them on, and that the testing benefited from the presence of the naphthalene. It was always particularly difficult to make statements after a short experiment. They only had four or five months' working; and he must confess that the day before coming away his Chief Inspector told him he had that morning received several complaints about naphthalene stoppages. Perhaps, therefore, if he had made the statement a week ago, he might have been stronger on this point; but now it would appear that, when they got into what some might regard as summer weather, they were getting more complaints than in the winter time. It seemed to him that, from Mr. Botley's point of view, it was a great pity they had not recently experienced those changes in temperature during the winter that they had had some three or four years ago. He did not think his system had had a fair trial; and he wanted to draw attention specially to the fact that they had been able practically, by the use of water gas, to do away with naphthalene deposits. He did not say the naphthalene was picked up by the water gas, or prevented from being deposited. How to explain it, he did not know; but they had been using the same coal as Mr. Botley used, and supplying gas of from 15½ to 16 candles.

Mr. Botley said he should like to ask Mr. Glover what proportion of common coal gas he thought it would be necessary to bye-pass, in order to bring up the gas to the quality he said he could get without cannel. He understood him to say that where the illuminating power did not need to be high, if one bye-passed the gas distilled at a low temperature from common coal, sufficient enrichment would be obtained without anything else. He might add, with regard to Mr. Helps's remarks, that during 1895 the temperature went down to as low as 12°. There was as much variation as for many years past.

Mr. T. Holgate (Halifax) said he had not had the privilege of reading the detailed statement referred to in the paper as to the quality and volume of the gas produced in connection with these experiments; but it appeared to him that, if they had the volume of gas, the illuminating power, and the nature and quality of the tar product when the cannel was distilled at the high and low temperatures, it would be very valuable. Mr. Samuel Glover gave the information that where Young's oil-gas process was in use there was still trouble from naphthalene in the services. Speaking from memory, he believed the gas made by the Peebles process was almost entirely free from benzol and benzine analogues; the illuminating power being chiefly due to ethylene. In the case of water gas, there was usually present a small quantity of benzol, which might account for the solvent action on naphthalene. He appreciated the remark Mr. Browne made in opening the discussion, which

placed the process in a clear light. It appeared to him that the authors had the means in their hands of testing how much improvement was due to the low temperature of distillation, and how much to the admixture at the outlet of the condenser. If they would pursue their investigations in this direction, the members of the Institution would be very pleased to hear the result.

Mr. E. A. HARMAN (Huddersfield) said he almost wondered the paper had not been intituled "Another Cure for Naphthalene." The subject was certainly a most attractive and practical one. Mr. Botley gave them an interesting paper at the last meeting, and so had Messrs. Glover that day; and in Huddersfield they had a system of low-heat carbonization with oil having the same effect for its object. They had, therefore, a large quantity of information as to how to prevent naphthalene. But, in spite of this accumulation of knowledge, naphthalene occurred, and would probably continue to occur for some time. It was only by such papers as these, and a careful consideration of them, that they would be able to arrive at a satisfactory solution of the difficulty. One of the chief practical points seemed to be the separation of the tar at the hydraulic main. Formerly it was usually allowed to flow with the gas down the foul-gas main almost as far as the condenser. In many modern gas-works the tar was now taken off at the hydraulic main by a system of overflows, and run away in pipes quite distinct from the gas itself. He believed the nuisance could be traced in some works to the date when the old system of tar drainage was superseded by a system of adjustable tar and liquor overflows having baffle-plates which compelled the tar to flow away before the liquor. His own opinion was, having tried several preliminary experiments, that the climatic conditions were chiefly responsible—principally very warm days followed by very cold nights. One year they might go without a single stoppage straight through; and if they were only fortunate enough at the commencement to have started some little fancy process, they might be ready at the end of the year to patent it; but, unfortunately, as soon as they started experiments the naphthalene nuisance recommenced.

Mr. A. E. BROADBERRY (Tottenham) said he was not prepared with any figures; but Mr. Browne had put a question to him about their being troubled with naphthalene since they had gone in for water gas. He told him that, up to the time they commenced, they had considerable trouble from this source; but immediately they began to supply water gas (using about 35 per cent.), the trouble practically ceased. It first dropped for two days to about 5 per cent. of the complaints they had had, and gradually disappeared altogether. Since then, they had occasionally had slight troubles with naphthalene, but did not find they coincided so much with the variations of the atmosphere as with variations in the temperature of the checker-work due to searching for better oil results. If the temperature were too high, they generally found they had slight troubles from naphthalene. This pointed to the correctness of the claim made by Mr. Glover with regard to low-temperature distillation. They had not been in quite so happy a position as Mr. Helps, who had better results at a distant testing-station; but there was considerably less falling off in the illuminating power at a distance from the works than before they started carburetted water gas.

Mr. F. W. CROSS (Lea Bridge) said he was rather surprised to hear Mr. Browne say that stoppages in certain places where they used water gas were more frequent now than they were some year or so ago; but this had been somewhat modified by Mr. Broadberry's statement, which was to the effect that the stoppages he had observed depended on the heat of the chequer-work in the superheater. His experience was this: When they started using carburetted water gas, they passed the whole of it into the coal-gas apparatus at the inlet of the exhauster. They had no trouble with naphthalene on the works; but in the district they had a surprising increase in the number of stoppages. They, however, got over this in course of time, and were now practically free; and he was of opinion that what stoppages they did get now were not altogether due to naphthalene. Just before Christmas, he had put in some new apparatus, by which they passed all the water gas direct from the plant, and effected the mixture with the coal gas at the inlet of the holder; and since then they had occasionally noticed naphthalene on the works. He never had much trouble with it; but if ever he did, he should simply revert to the old state of things, and pass the water gas through the coal-gas apparatus. In the event of very severe weather in the future causing trouble by naphthalene stoppages, he should at once increase the quantity of oil and make a richer gas; and this would act as a carrier for naphthalene under the more adverse circumstances.

Mr. W. FOULIS (Glasgow) asked what Mr. Glover meant to imply by "low temperature." There was no doubt that by distilling cannel at a suitable temperature, a gas was produced of greater enriching value than that which was obtained when a higher temperature was employed, even though the latter might give a larger quantity of gas per ton. The author said he now found that only half the quantity of cannel formerly used was sufficient to maintain the quality of his gas; and the question was, At what temperature was the cannel previously carbonized, and what temperature was used now? It was a very excellent result to produce 19-candle gas at 7d. per 1000 cubic feet; and they would all be glad to be able to do the same. But until they had further information as to temperatures, present and past, it was difficult to discuss the paper. When using oil gas for enrichment, it was found that to obtain the best results it was necessary to keep the temperature of the retorts within a comparatively small range; and when carbonization was effected within these limits, a gas was obtained having a much higher enriching value than was shown on the photometer when the oil gas was tested by itself. At his works, they were at present enriching about 5 million cubic feet of gas to the extent of 3 candles, with no more than 2000 gallons of oil.

The PRESIDENT said there had been a very interesting discussion, though it had turned more on the question of naphthalene than anything else. One of the important points in the arrangement of this plant, which evidently must have a very strong influence on the results obtained, had been somewhat lost sight of. Mr. Glover did not mention the temperature at which he kept the cannel gas up to the point when he mixed it with the coal gas. He said he kept the temperature up with a steam-pipe. The cannel gas was conducted by a 6-inch pipe 250 feet long, falling all the way from the hydraulic main; and the temperature was kept up to such an extent that where it entered the outlet of the condenser, the cannel gas was still at 120°. The gas it was mixed with was condensed to 60° or somewhat less. There was an open syphon fixed at the end of the pipe; and deposits of liquid were falling with it, principally water, though there was a little oily matter on the surface. To his mind, this was an interesting feature. One had a certain quantity of gas produced from cannel at a moderate temperature—not very low—and evidently densely charged with hydrocarbon vapours. The temperature was kept up until it was suddenly introduced into a large volume of thin gas, which had already had all its tarry matter condensed out of it, and with that probably all the naphthalene that it could not continue to carry. The temperature of the bulk was thus raised about 9°. This seemed an interesting feature of the apparatus, and very suggestive, as regarded the capability of the gas to sustain these hydrocarbon vapours when introduced in such a manner. With regard to the naphthalene question, there were one or two facts which it was well to bear in mind. One was that naphthalene did not appear to be deposited so long as the gas contained any vapours in a state of mist, or on the point of being themselves liquefied. So long as one found liquids in the mains, naphthalene was not discovered. It was only found when they were dry. Did not this show that any system of enriching gas (or "fogging" it as Mr. Botley called it), which gave the gas an oleaginous vapour, would prevent stoppage by solid naphthalene? This might be effected by such a process as Mr. Botley introduced, by the one now brought forward by Messrs. Glover, or by a mixture of water gas in which the hydrocarbons were not all thoroughly fixed. The Peebles oil gas was different, for the simple reason that it was a truly permanent gas, and nothing was deposited from it. He did not know whether he correctly understood Mr. Botley to say that the enriching value of carburetted water gas was less than its illuminating value.

Mr. BOTLEY said it was about the same; whereas the Peebles oil gas, being more permanent, had a greater enriching value.

Mr. S. GLOVER said he was very well satisfied with the tone of the discussion. What they wanted to do was to emphasize the fact that gas depended for its illuminating

power on its composition, which fact had not perhaps been sufficiently realized; and it depended for its composition very much on how the coals from which it was produced were dealt with. By this process, they claimed to do much more than Mr. Foulis mentioned. It was not simply carbonizing cannel at a low temperature—in fact, he did not like the phrase "low temperature" so well as the one Mr. Foulis suggested—"suitable temperature." But the process did not consist simply in carbonizing the cannel at a different temperature, but in the way in which the whole of the products from the cannel were dealt with—and not merely the gas. The heavy tar was left behind the take-off pipe rising from the top of the hydraulic main. A lot of valuable hydrocarbons were carried forward along with the cannel gas in this pipe, and were kept hot by means of the steam-pipe, until they were presented to the coal gas which had been denuded of its tar. They had, therefore, valuable hydrocarbons, specially prepared—which were valuable for enriching, and also for treating the naphthalene—presented to a medium which was the best that could be provided for developing the illuminating power of the hydrocarbons. With regard to the question as to the use of coal instead of cannel for this process, they had not any very well-ascertained facts; but the idea was that 7 to 8 per cent. of coal would be required to raise the illuminating power 1 candle, and that by treating coals in the same way as cannel not only would an enriching gas be obtained, but also a solvent for naphthalene. There had been a good deal of remark as to the various effects of mixing water gas with coal gas; and this was no doubt owing to the varying temperatures to which the oil was submitted in a water-gas plant. Some of the oil was cracked up at too high a temperature; while some of it might not have been cracked up sufficiently. They claimed that they had reliable results, because the thing was under proper control. No doubt, as Mr. Broadberry said, a great deal of the advantage was obtained by the lower temperature at which they treated the cannel, producing richer hydrocarbons. With regard to the effect of Peebles oil gas on naphthalene, there was no doubt that so far as it was mixed it acted as a preventative, inasmuch as the oil gas had no naphthalene in it at all. But the quantity required for enriching was so small that it had little opportunity of preventing the formation of naphthalene. Where cannel was too costly, he should recommend the use of coals.

Mr. T. Glover said there was only one point he need refer to, and that was the very considerable gain in sperm value by using cannel in this way, compared with allowing the gas to mix in the foul main; the gain in sperm value per ton of coal being equal to 50 lbs.

WASHERS AND SCRUBBERS.

By Edward A. Harman, of Huddersfield.

The subject of the paper may be considered as divided between chemistry and engineering. In order to rightly appreciate the functions and duties of washers and scrubbers, it is desirable to review the conditions under which gas is liberated in its distillation from coal.

Coal is the remains of vegetable matter (wood fibre, &c.), composed of carbon, oxygen, hydrogen, nitrogen, &c., which has been submerged in water by land changes time after time. Thus it was covered with muds and detritus flooded down from adjoining lands, and saturated with mineral matter in solution. This is evidenced in the small veins of coal, the interstices of which are filled with finely-divided soluble substances. In coal distillation, therefore, the gases given off do not correspond entirely to those obtained from wood, but consist also of considerable quantities of others. The decomposition by heat liberates sulphur, which at high temperature combines with the hydrogen and carbon given off to produce sulphuretted hydrogen and carbon bisulphide. In addition to these, the nitrogen combines with the hydrogen given off to form ammonia, while the carbon and hydrogen chemically combined in the coal are liberated as hydrocarbon gases. The vapours are all condensable, as, indeed, are all the gases under certain conditions; but it is the wide difference in their condensing points which enables the surplus hydrogen, marsh and olefiant gases, to pass unarrested through the processes in use for the extraction of impurities.

To appreciate the changes which take place in distillation, an analysis of the gas, after it has deposited a large quantity of its vapours in the hydraulic main, cooling mains, and condensers, will suffice. The composition of the gas at the outlet of the condenser, for the purposes of consideration, may be approximately taken as follows:—

	Grains per 100 Cubic Feet.	Per Cent. by Volume.
Tar	—	Some vapours.
Ammonia	220	0·70
Sulphuretted hydrogen	950	1·50
Carbon dioxide	1640	2·00
Carbon monoxide	2600	5·00
Carbon bisulphide, other sulphur compounds, and cyanogen	70	0·05
Oxygen	—	trace
Hydrogen	1850	50·00
Nitrogen	2000	4·00
Marsh, olefiant, and other gases	—	36·75
Total		100·00

The question, therefore, is, which gases require retaining and which eliminating, and the best method available for accomplishing this end.

Hydrogen burns with a non-luminous, but intensely hot, flame; and the products of combustion are imperceptible. It is very slightly soluble in water, 100 c.c. dissolving about 2 c.c. of the gas. Hydrogen forms about 11 per cent. of the weight of water and 25 per cent. of the weight of marsh gas. It is, moreover, an essential element in the extensive class of bodies termed acids. Marsh gas, or methane, carbon monoxide, and gaseous hydrocarbons, when burnt, do not have a deleterious effect. Carbon dioxide, nitrogen, and ammonia, detract seriously from the illuminating power of the gas, inasmuch as they require to be heated to the temperature of the burning gases, and abstract proportionately from the heat of combustion of the others. Sulphuretted hydrogen and bisulphide of carbon burn with a pale blue flame; the irritating fumes and vapour therefrom having very injurious effects.

The objectionable gases for removal are carbon dioxide, ammonia, sulphuretted hydrogen, and other sulphur compounds. These gases are soluble in water approximately as follows: One volume of water at 60° Fahr. absorbs 700 volumes of ammonia, 3¼ volumes of sulphuretted hydrogen, and 1 volume of carbonic acid.

It is well known that the solubility of gases decreases rapidly with an increased temperature of the liquid to which they are exposed. Carbon bisulphide is insoluble in water. Ammonia, being a very strongly alkaline body, is capable of neutralizing acids; while carbon dioxide and sulphuretted hydrogen are acid bodies. These will, under suitable conditions, combine—that is, the acids with the alkali—to produce salts. Similarly, sulphuric acid absorbs ammonia, as illustrated in a sulphate of ammonia plant, with the exception that whereas sulphuric acid, as a strong acid, possesses great affinity for such powerful alkaline bodies as ammonia, the others, carbonic and sulphidric acids, are only very weak ones, so much so that they only exhibit acidic properties when in solution, and then but very faintly. Their combinations with ammonia under the most suitable conditions only produce unstable salts, which at ordinary temperatures break up slowly, and at higher temperatures very rapidly, into their constituents. One of these salts—ammonium carbonate—is used in the estimation of the sulphur in the gas in the Referees' test, as it gives off a portion of ammonia at the ordinary temperature to the products of the combustion of the gas. If these bodies could be combined to saturate each other and produce salts, they would be removed from the gas to the extent of the whole of the ammonia and half the volume of carbonic acid or sulphuretted hydrogen.

The properties already mentioned suggest at once a means of freeing the gas from impurities—viz., either dissolving out with water, or combining the alkali and acid bodies and producing salts. The readiest means available, taking into account their solubilities, is to wash the gases. From the great solubility of ammonia in water, it might be conceived that its removal would be a most simple matter; but in actual practice it is not so easy as it appears. It only exists in the gases to a very trifling amount when compared with the volume. For the purpose of comparison, we will consider it to be about 7 in 1000 by volume. One ton of coal, yielding 10,000 cubic feet of gas, therefore contains about 70 cubic feet of ammonia, and would only require theoretically 0·1 cubic foot of water, or about 5 pints, to dissolve it. In actual working, this is far from sufficient. The water is never thoroughly saturated, and, moreover, the solubility takes place directly in proportion to the pressure of the contained gases. If ammonia gas were

confined alone in a vessel at 30 inches of mercury, or at ordinary atmospheric pressure, it would be absorbed to the extent of 700 times the volume of water in the vessel; whereas ammonia, existing in the proportion of 0·7 of its volume as a gas, will only exert a pressure of 0·007 of an atmosphere, or 0·21 inch of mercury, at which pressure very little ammonia is dissolved per volume of water, on account of the small partial pressure of the gas, though it is able to retain it when dissolved, because the water is at atmospheric pressure. Therefore the successful abstraction depends upon the time-contact between the gases and the water. It is this which has suggested the desirability of a washer being worked under pressure.

Carbonic acid and sulphuretted hydrogen are affected similarly; so that to remove these, if the solubility of them could saturate the water used, a great deal of plunging and agitating of the water would be necessary to effectively remove them. Indeed, it is this object which has been aimed at in purifying machines, concerning which more will be said. Other considerations have also to be taken into account—viz., the instability of ammonia, carbonic and sulphidric salts. Their instability is augmented, as that of the solubility of the ammonia, by the temperature. Whereas at ordinary temperatures the before-mentioned solubilities were obtained, a variation of a few degrees interferes seriously with the result, as shown by the following table:—

One Volume of Water Absorbs—

Temperature, Deg. Fahr.	Carbon Dioxide.		Sulphuretted Hydrogen.		Ammonia.	
		Loss per Cent.		Loss per Cent.		Loss per Cent.
60	1·002	..	3·23	..	700	..
62	0·973	2·9	3·16	2·1	..	..
64	0·938	6·3	3·03	6·2	..	..
68	0·904	9·7	2·90	10·2	..	..
176	..	..	..	..	200	71

The effect of temperature upon the deposition of ammoniacal salts, particularly in the case of sulphidric and carbonates, is very clearly and decisively shown in the composition of the liquor obtained from the hydraulic main, where the temperatures vary from (say) 140° to 180° Fahr. The hydraulic main liquor contains only about one-sixteenth of the proportion of the sulphides and carbonates deposited in the condenser; while such salts as sulphates, sulphocyanides, &c., are almost wholly left in the hydraulic main liquor. The liquor contains also far less free ammonia than other parts of the washing and scrubbing plants. The fixed ammonia from the hydraulic liquor is approximately 50 per cent. of the total ammonia in it. As the temperature lowers, the sulphides and carbonates of ammonia tend to form very soluble salts, which become dissolved in the aqueous vapour of the condenser, and are found there in the largest quantity. The alkaline and acid bodies contained do not combine to saturate each other to the full limit, since, being only a small proportion of the gas, their pressures are too attenuated. These salts, too, dissociate rapidly at ordinary temperatures. This phenomenon is well known.

Limestone heated in a closed vessel parts with carbon dioxide until the gas liberated exerts a particular pressure. If this gas be pumped off, a further dissociation of limestone occurs, until the further carbon dioxide exerts the pressure at which dissociation ceases. This would continue if the carbon dioxide were pumped off as formed until the limestone was completely decomposed. The inverse would occur by lowering the temperature or by increasing the pressure. Thus it is with the carbonic and sulphidric salts. Their partial pressures in the gas are such as to almost prevent any mutual attraction they might exert, and be dissociated as quickly as formed. Consequently, they do not form, or probably only to a very slight extent. The tendency would be enhanced by washing with alkaline solutions such as gas liquors. It is therefore most important to reduce the temperature of the gas. The escape of ammonia from the scrubbing process during the summer and warmer months is sufficient proof of the dissociating effects of heat, and its influence in effective washing. Sudden cooling is apt to condense out the valuable vapours, and must be avoided.

The quantity of water desirable is a question for careful calculation. Ammoniacal liquor has value as a commercial product, which is dependent upon its strength, and has to be considered. In addition, the washing of the gas by too much agitation with fresh water dissolves and precipitates some of the illuminating constituents. It is consequently desirable to wash the gas with solutions which have previously been partially saturated up to almost saturation-point. The quantity of liquor deposited in the hydraulic mains and condensers equals about 50 to 60 per cent. of the total liquor obtainable. This liquor is used for the first washing because it is to some extent saturated with gas, while it is not strong enough to work up profitably in the sulphate plants. The quantity of this liquor is more than sufficient to absorb all the ammonia existing in the gas. The last washing has to be done by clean water, of which about 10 gallons per ton of coal has generally been found sufficient. The reason weak liquor does not effectually remove the whole of the ammonia is because of the before-mentioned dissociability of alkaline sulphides and liquors, the vapours of which are given off appreciably at all temperatures; thus necessitating the application of clean water for the finishing operation.

The best method for washing operations is a matter of great difference of opinion. Water, in order to take ammonia into solution, must be brought into actual contact with it before union can be effected. This contact is made by causing the gas to rub against the surface of the water, and may be accomplished by various methods. It may be brought into contact by allowing it to traverse a column down which is falling a continuous shower of water like rain or spray; or it may pass over a large wetted surface; or it may be agitated in water and forced into small bubbles. It has been pointed out that the effectual removal of the ammonia depends upon the time-contact. Suppose water to be distributed down a tower or scrubber, passing 3 million cubic feet of gas per diem, at a rate of one volume of water to every 1000 cubic feet of gas passed, or nearly 13 gallons—say, approximately, 2 cubic feet—per minute. Consider the water to be divided into drops of $\frac{1}{4}$ inch diameter, the contents of which equal 0·00818 cubic inch. Then the number of drops represented by this quantity would be 2 cubic feet divided by this amount, which equals 422,494 drops. The surface presented to them would be 576 superficial feet area ($\pi a^2 \times 422{,}494$); and they would be in contact with the gas during the time taken to fall down the tower. This surface area would be increased by dividing the drops finer, as by means of a spray distributor. The mechanical power required to obtain minute distribution is in excess of the relative value of the finely-divided spray over a simple system of drops. In dividing the gas into bubbles, a very different case is presented. It is far easier to subdivide the gas into anything chosen than to subdivide water. All that is required is to keep the liquid well agitated, and let the gas issue into it. Washers are based on this well-known principle of compelling the gas, in a finely-divided form, to pass through a liquid instead of merely over a surface.

In purification, experience has an important part; for, while the laboratory results form an admirable comparative guide, there are forces which come into operation upon the manufacturing scale, when treating millions of cubic feet, that are not apparent when experimenting with a fractional part. It is to the most desirable designs of apparatus for effecting purification that attention and experience are invited.

The washer is one of the earliest forms of apparatus for extracting ammonia and tar. It was frequently used without due regard to its limitations, and so as to materially reduce the illuminating power of the gas; and it was probably this, coupled with the heavy back-pressure of some of the old designs, which retarded its extension. Indeed, the back-pressure alone was sufficient to discredit any apparatus. It is, or should be, always used either in connection with a scrubber or a scrubber-washer, and always before them. The primary idea of the washer was very good—viz., that of extracting the tar and a large percentage of the ammonia. As stated, the reason the washer does not remove every trace of ammonia is that it cannot be kept charged with clean water, as the gas converts the water into ammoniacal liquor; and the last contact of the gas is therefore with the liquor instead of with clean water.

In 1891, an admirable paper upon the efficiency of washers was published by Dr. Bueb, Chemist to the German Continental Gas Company. He stated that at

the Elberfeld Gas-Works the separation of ammonia was effected throughout half the works by means of washers.*

Temperatures.—Both washing and scrubbing could be effected better if a complete control were obtained of the temperatures of the gas at all portions of the apparatus. It is with this object in view that the condensers abroad are generally placed in closed houses. Where washers are erected in the open air, the liquor therein frequently falls below 60° Fahr., with serious reduction of the heavy hydrocarbons. It is therefore desirable to have the washing apparatus enclosed.

Tar Extraction.—In the United Kingdom, the common practice is to extract whatever tar is left in the gas after condensation at the washers and scrubbers, which has, however, the objectionable point of rendering these portions of the purifying plant less efficient for their particular work. Upon the Continent, preference is given to the extraction of tar by means of tar extractors, such as those of MM. Pelouze and Audouin. It is true that this has been adopted in some few works at home, as well as other systems of tar extraction. The separate operation for mechanically extracting the precipitated tar or floating particles is a debatable question. The object of many gas engineers is to condense out the tar, which, of course, necessitates large condensers—certainly larger than would be required if the tar were previously extracted. Even with large condensers it is impossible to condense out all the tar at atmospheric temperatures. Many engineers prefer the gas remaining in contact with the tar as long as possible. It is questionable whether it is desirable to bring down the temperature of gas to 60° before washing; the object of doing so being principally to reduce the quantity of tar in the gas.

Scrubbers.—The form of tower scrubber most familiar is, perhaps, the Mann and Walker type. It consists of a cylindrical tower, the height being about three to five diameters. A machinery room adds finish and ornament to the top. In the upper portion of the vessel is a brushwood wheel, which receives a supply of clean water from revolving water distributors, ingeniously designed to work eccentrically, so that in traversing the outer circumference of the vessel they move slowly; but when nearing the centre, rapidly. The gearing is worked by bevel wheels from a vertical shaft, supported from the sides of the vessel. The contained material generally is either coke or boards on edge, although other material is also used. The channelling of the gas and water through coke makes boards preferable. The material is supported on a series of cast-iron grids, leaving each tier distinct and separate for the dispersion and diffusion of the gas. The gas enters at the base, meeting the strongest and warmest liquid, and passes from tier to tier vertically to the top of the vessel, where it descends an outlet-pipe placed in the centre. The water, entering at the top in the form of finely-divided spray, descends through the material, and the gas being forced through the separate tiers gets well brought into contact with the moisture and sharp edges. Mr. William Mann, formerly Engineer to the City of London Gas Company, and Mr. William T. Walker, with whom the author had several conversations upon the subject, strongly recommended the gas always to be passed through the scrubber under pressure, instead of exhausted. The gas yields its ammonia to the water; the tar is mechanically arrested by the coke, and drains to the bottom of the vessel, the base of which is generally designed to permit the tar and liquor draining to the outlet-pipe leading to the store-well. Where a series of tower scrubbers are used, weak ammoniacal liquor is pumped into all except the last or finishing one, in which clean water is employed. The ammoniacal liquor when treated in this manner becomes a valuable purifying agent, and is also itself much enhanced in value. One advantage of using liquor is that the hydrocarbons are not deposited as when water only is employed. When scrubbers are used in the dry state—that is, without a liquor or water supply of any kind—the material necessarily extracts or retains the tar only.

Tower scrubbers require cleaning out about once in every eight to ten years. They may be partially cleaned at intervals by steaming; always taking care to commence the steaming process at the top, and following down tier after tier, so as to allow the condensed water and liberated tar to drain downwards, leaving the upper tiers cleaned. As regards the most desirable material for use in scrubbers, Mr. George Livesey (to whom belongs the credit of introducing boards) gives the following relative area of wetted surfaces:—

Coke	8½	square feet per cubic foot.
Drain-pipes 2 inches diameter .	21	" "
" 3 " " .	17	" "
Boards	31	" "

It will be seen that, apart from other desirable recommendations, boards present between three and four times the area of coke material.

In a tower scrubber filled with grids of ⅜-inch by 9-inch boards, with ⅜-inch distance-pieces, a very large surface is exposed for wetting, and consequent frictional surface-action on the gas. In a tower designed for passing 3 million cubic feet of gas per day of 24 hours—say, 15 feet in diameter and 60 feet high—having six tiers of grids, the surface equals 268,000 square feet. These grids occupy 40 per cent. of the cubic capacity of the tower. In the tower there is approximately 10,602 cubic feet, less 4356 cubic feet filled with material; leaving in the interstices some 6246 cubic feet. The inside of the scrubber, together with the surface area of the grids, presents 270,820 square feet. The gas passes at 34 feet per second, and will be in the interstices of the material such a time as it takes to fill up the 6246 cubic feet divided by 34, which equals nearly 3 minutes. Multiplying the surface—268,000 square feet—by the time, and 804,000 square feet are obtained, which is the value of contact with the gas passing. The result may be written $\frac{\text{total surface}}{\text{volume of gas}}$, which expresses the amount of contact surface available for each volume of gas. The capacity of any washing-machine may be gauged from this rule, independent of design. Again, gas, as has been referred to, may readily be reduced to bubbles of very small diameter, and by this means the contact surface can be obtained equal to any other. Suppose the gas is divided into bubbles of ¼ inch diameter, then for each cubic foot of gas we obtain about 288 square feet of surface area. As gas rises through one foot of liquor in about one second, for this to equal the capacity of the tower scrubber described it would have to pass through a column of liquid 27 feet deep. The expenditure of power to effect this would be very much in excess of the force required to deliver 13 gallons of water to the top of the tower.

The late Mr. Wyatt recommended 100 cubic feet of internal capacity of the vessels, with a gas contact of from 15 to 27 minutes for maximum and average makes; and he stated that 12½ to 15 per cent. of this volume could be utilized by introducing a washer into the base of the scrubber.* The volume of gas contained in the scrubbers at one time amounts to about 1 per cent. of the maximum make per diem. The horizontal net area of all the scrubbers recommended by Mr. Wyatt is equal to 2 superficial feet per ton per diem on the maximum make. The late Dr. Hurter's paper on "Coke Towers" and similar apparatus, in 1893,† is a valuable contribution to the subject.

Water Distributors.—It is difficult to ensure thorough distribution over the whole area of a large scrubber, though accomplished at the first tier; the liquid collects and drains in channels through the remainder. The author has tried jets of steam in each tier, with good effect as to saturating the material all over; but the increased temperature of the gas prohibits its use. The Barker's mill arrangement is perhaps one of the best forms. Gurney's jet consists of a sliding tube with a nozzle, having a fine hole 1-64th of an inch in diameter. The liquid is forced through this at considerable pressure, causing it to impinge against a circular glass disc. Green's water distributor, Goldsmith's, and many others, might be cited.

Washers.—Washers are of numerous designs. The gas passes through a series of perforated plates, brushes, bundles of grids, and many other devices placed in chambers, and constantly wetted. The surface of these, and the contact, are enormously increased in many cases by constant revolution, and possess advantages, inasmuch as the liquor is retained without pumping; being gradually run off as the strength increases. The gas leaves behind the larger portion of its ammonia in the chamber. The liquor, being retained, is consequently worked up to a far higher degree of saturation. An analysis of the liquor from one of these washers shows clearly the action of the gas. In the first chamber, a little of the fixed ammonia is

* See "JOURNAL," Vol. LVIII., p. 576.

* See "JOURNAL," Vol. L., p. 662.

† See "Journal of the Society of Chemical Industry," Vol. XII., p. 227.

obtained; while the free ammonia, or that held in solution with such weak acids as carbon dioxide, will seem to have displaced the sulphuretted hydrogen, it being found there in the proportion of 70 per cent., compared with the sulphuretted hydrogen similarly held. In the latter chambers the sulphuretted hydrogen seems to enter more into solution. In the last chamber it is side by side with the carbon dioxide, and is found up to 50 per cent. The acid equivalents throughout the series get gradually less. The proportion of carbonic acid and sulphuretted hydrogen in the liquor, and the proportion they bear in relation to each other, vary, principally owing to the strength of the liquor, and partly under the circumstances of formation. Generally between 50 to 70 equivalents of alkaline ammonia are combined with 50 to 70 equivalents of the acids, carbon dioxide, and sulphuretted hydrogen, the sulphuretted hydrogen of which forms nearly 20 per cent. The strong liquors contain less than the weaker ones. The operations of washing remove 2 or 3 grains of carbon bisulphide per 100 cubic feet; and the illuminating power is slightly diminished.

It has been shown why the alkaline and acid bodies do not combine to eradicate themselves, on account of their non-affinity at the partial pressures in which they exist in the gas. It has also been shown why the water, compared with the solubility, is insufficient to eliminate the ammonia. When the pressure becomes more attenuated, the forces between the dissociability of the weak solution more nearly approximate equilibrium—a rise in temperature effecting the liberation of a small quantity, or a corresponding lowering effecting the absorption. The relative capacities of washing the gas by rain vapour, material spread, surface contact, breaking the gas into bubbles, and the presentation of new surface area to the action of the gas in the various forms of mechanically worked washers, have been dealt with. Rain vapour is of little practical use, the mechanical force necessary to present it in this form being far from the advantage derived from washing the gas by breaking it into bubbles. The mechanical force necessary to break the gas into bubbles, simple as it appears, is greater, while the surface thus obtained is less, than is required for passing the gas through tower vessels with large surface area. Even these are behind mechanical washers of various kinds, as their surface contact can be regulated; and it is also enhanced by utilizing strong liquors for the crude gases. While considering surface contact, it may be mentioned that a limit may be obtained in the fineness of the layers presented to the surface, inasmuch as the material required to do this occupies a greater portion of the cubic area of the tower or machine; thus accelerating the flow of the gas, and not allowing the time contact necessary for the absorption of the constituents it is desired to extract.

The "Livesey" Washer.—The washer designed by Mr. George Livesey consists of a rectangular cast-iron box, the upper part being formed into an inlet chamber, together with one or two outlets. To the lower flanges of these inlet chambers are fastened a series of wrought-iron tubes, having holes 1-16th of an inch in diameter. The interior of these tubes is in communication at the ends with the outlet chambers, while the spaces between them at the ends are securely closed up. The gas has free access from the inlet chamber direct to these intermediate spaces; passing down them, and depressing the liquor until the gas escapes through the inclined portion of the perforated plate to the first space, which is filled with liquor, through which it bubbles until it comes in contact with the horizontal part of the perforated plate, carrying some of the liquor with it to the upper surface of the plate. The bubbles of gas pass through this liquor into the tube space, and convert the surface into light foam, which flows along with the gas into the outer chambers. The liquor drains from the washer by means of overflow-pipes, by which the level can be adjusted as required. The inlet for the liquor supply is placed at the lower part of the washer. Glass windows are fixed in the sides at opposite ends of the tubes, so that the bubbling and washing of the gas in the tubes may be clearly observed. Special provision is made in the lowest part of the chamber for the collection of the tar, which is separated, and falls to the bottom, being drawn off from that level, independently of the liquor, at regular periods. The apparatus possesses the great advantage of being absolutely automatic, and requiring only a trifling amount of attention; while, for its compactness and the small space occupied, it is probably the most economical and efficient type in existence. By the minute subdivision of the gas, which is brought twice into contact with the liquor, the entire removal of all the tar and the greater part of the ammonia is ensured. In some works the ammoniacal liquor from the tower scrubbers flows by gravitation, *viâ* a tar and liquor separator, direct into the washer, which is fixed at a desirable level for the purpose. The number of perforations through which the gas has to pass per foot of trough is 3264; thus dividing the gas into many thousands of streams. Where more than one of these washers is used, they are placed at different levels, to admit of the liquor gravitating from the last one to the first. The extensive adoption of this washer is sufficient guarantee of its efficiency.

The "Charles Hunt" Washer.—The "Charles Hunt" patent washer is, in reality, a combined washer and scrubber. It is perfectly automatic. It consists of a series of chambers placed one over the other. The gas enters at the base and issues through vertical tubes, over which are placed inverted troughs sealing each compartment in liquor. Water is admitted at the top, and descends from tier to tier to the bottom; so that the gas on entering meets with warm liquor, and in its ascent is subjected to cooler liquor, until at the outlet in the last chamber it meets clean water. This gradual cooling of the gas is in accordance with the consensus of opinion as being the best preventative for naphthalene stoppages. This washer possesses the advantage of being readily adjusted for variable makes of gas. A series of test-cocks are provided for ascertaining the actual duty performed in each chamber. In the lower tiers, when desired, weak ammoniacal liquor from the hydraulic main and condensers can be admitted. One of the chief features is the enormous area of washing surface presented to the gas. The small ground area required by the apparatus is a great advantage, especially where the site is limited. The adjustment of the depth of seal in each chamber can be made in a few moments while working. It is a most efficient apparatus.

Marshall's Scrubber and Condenser.—Mr. Marshall, of the Copenhagen works of the Danish Gas Company, has designed an effective combined condenser and scrubber. The gas passes in a downward direction between tubes, through which water is pumped in an upward one. The warm gas thus meets at the inlet with a moderately warm condensing surface, and is gradually cooled in its passage through the apparatus. Water is dripped over the exterior of the water-tubes, and the condenser becomes an effective scrubber, as the tubes present a considerable area of wetted surface; while a secondary effect of the trickling water is to clean the tubes from any deposit of tar, &c. The water is prevented from running down the sides of the condenser by a series of drain-plates. One battery of seven sections is capable of condensing 350,000 cubic feet of gas per 24 hours from 142° to 63° Fahr.; the temperature of the inlet water being 60° Fahr. The consumption of water to effect this result averages 5000 gallons. The battery contains 1054 square feet of water surface, and 204 square feet of air surface. The apparatus is automatic, and does not require machinery other than for water purposes.

Anderson's Washer.—Mr. Anderson has always strongly advocated the use of washers. His design is composed of a chamber containing a number of trays, underneath which a series of serrated bars extend from side to side. Weak liquor is admitted at the top. The trays seal in liquor, and the gas issues through them minutely divided.

Young's Washer.—The washer designed by the late Mr. Hugh Young, the Engineer of the extinct Birmingham and Staffordshire Gas Company, consisted simply of high cast-iron rectangular vessels filled with wooden boards, through which the gas traverses up and down in two or more sections; being thoroughly drenched with liquor, a continuous supply of which descends from the top.

Reid's Washer.—Mr. John Reid's rotary washer, made for the Edinburgh and Leith Gas Commissioners, consists of two hollow cylinders, all round which are fixed buckets, giving the appearance of a large water-wheel. The wheels, revolving in a tank of liquor, discharge their contents inside the cylinders, which are revolved by a rack, fixed on their circumference, actuated by a pinion.

The "Holmes" Washer.—Messrs. W. C. Holmes and Co.'s patent scrubber-washer is in successful use in many gas-works. It is of the horizontal rotary form. The washing

substance therein consists of a series of brushes made from a weed which has grown in water; thus ensuring a minimum amount of decomposition from the liquid contact. Such brushes contain an enormous quantity of wetted impinging surface for the small space occupied. This scrubber-washer, in addition to being one of the most efficient for removing ammonia, is also being used with considerable success in connection with cyanogen plants.

Kirkham's Washer-Scrubber.—This "Standard" washer-scrubber is of the horizontal rotary type. The purifying action consists in the gas passing at all points over a wetted surface composed of constantly revolving wood grids. These grids are arranged in a series of horizontal compartments, the division-plates forming them permitting the water to overflow from one compartment to another. The gas, in passing through in this manner, comes in contact last of all, at the outlet, with clean water. The "internal bundles" were formerly made of perforated plates; but in order to reduce the weight for the driving, &c., wood has been substituted. It is one of the most popular forms of washer-scrubber in existence.

Whimster's Washer and Exhauster.—Mr. Thomas Whimster's combined exhauster and washer, made by Messrs. Hanna, Donald, and Wilson, possesses several features of interest. A horizontal cylinder is divided into three compartments. Between these partitions there are a pair of revolving discs connected by a number of curved blades; thus constituting a series of bucket-like chambers. The gas entering the central division is carried down by the curved blades below the liquor level, and escapes through openings at the centre of the revolving drum, and up through the liquor into two side divisions provided with outlets. The principle of thus exhausting the gas during the washing operation is worthy of further development and adaptation.

Laycock and Clapham's Washer.—This is of the rotary horizontal type, consisting of compartments in which cylinders, fastened on a central shaft and filled with wood balls, revolve in ammoniacal liquor; thus ensuring the complete passage of the gas through, and in contact with, a large area of fresh and continuously wetted material.

The "Cathels" Washer.—The washer by Mr. E. S. Cathels is composed of a series of small washers, each of which is complete. They are elevated one above the other successively, and have also been placed one over the other vertically.

Walker's Purifying Machine.—Messrs. C. and W. Walker's machine consists of a rectangular vessel containing in its lower part a washing chamber, having on each vertical side numerous horizontal troughs, open at the bottom, which have fine perforated slits on each side. The washing chamber is filled with liquor to the level of these perforations. The gas entering the receiver fills the troughs, from which it displaces a quantity of ammoniacal liquor, and goes through the immersed perforations. It then passes through the stronger liquor outside, and is thus relieved of its tarry particles, which fall through the liquor into the bottom chamber, and are subsequently drawn off. The gas, after leaving the washing chamber, ascends through rectangular openings, over which are fixed the boxes of devices containing wetted boards. These devices are fixed upon vertical shafts in connection with gearing for moving them up and down in the liquid. The gas travels from chamber to chamber between the wetted boards in each tier, until it arrives at the top free from ammonia and tar, and a portion of the carbonic acid and sulphuretted hydrogen. The devices constantly dipping into the liquor expose to the gas a large amount of wetted surface. The number of dips per minute adopted at Huddersfield is about six, and this in a 3 million cubic feet machine equals about 10 million square feet per hour exposed to the gas; so that no portion of it can remain unwetted for more than one-sixth of a minute at a time. The action of this enormous wetted surface is to absorb the ammonia from the gas; thus forming strong ammoniacal liquor, which descends into the bottom washing chambers for the purpose of taking up the carbon dioxide. Clean water is admitted into the top at the rate of about 10 gallons per ton of coal carbonized; and this water descends from chamber to chamber. Weak liquor is admitted into the bottom tiers. The liquor overflowing into the next lower tier of the machine meets the ascending streams of the gas nearly wholly free from ammonia. Only about an inch of back-pressure is thrown by this machine, which is really a most efficient one. The power required for driving it is so small that a man can work the whole of the machine by taking hold of the fly-wheel and pulling it round with one hand.

Many different forms of washers and scrubbers have ingenious and interesting points with which the members are familiar, such as the following: The "Saville;" the "Coffey" still, which is sometimes used for a scrubber and washer; Mr. Paddon's excellent washer-scrubber; Mr. George Lowe's scrubber; Mr. Warner's scrubber; Mr. Cleland's steam scrubber; Mr. Anderson's brush scrubber; Messrs. Cockey and Sons', and many others. The examples described will probably be sufficient illustrations, as representative of the various designs in use.

Ammonia.—Almost invariably upon gas-works, all the ammoniacal liquors, whether from the hydraulic mains, condensers, cooling-mains, washers, scrubbers, &c., are drained into one common storage tank, though, having regard to the various compositions of these liquors, this is hardly a scientific way of dealing with them.

The question of the desirability of using purified liquor is too extensive for present consideration. In Hills's process, the ammoniacal liquor is passed through a kind of still, so regulated that about 50 per cent. of the sulphuretted hydrogen and carbon dioxide present are liberated. The purified liquor, as it is termed, is then run back into washers, and is ready to take up another quantity of these impurities. Ammoniacal liquor used in washers, unless purified by some such process as this, must not be allowed to be too heavily charged with carbon dioxide, or it will displace the sulphuretted hydrogen in a similar manner to that which obtains in the ordinary purifiers. The general principle is to heat ammoniacal liquor to a temperature of about 200° Fahr., when the greater part of the carbon dioxide and sulphuretted hydrogen are driven off; the bulk of the ammonia being retained.

Comparatively little attention is paid to the properties of ammonia at various temperatures. Coals contain from 1 to 2 per cent. of nitrogen, and hold about 14 per cent. of this amount as ammonia during distillation at ordinary temperatures. This represents 5·7 lbs. of ammonia per ton of coal. Thus—

$$2240 \times 1{\cdot}5 \text{ per cent.} = 33{\cdot}6 \text{ lbs.} \times 14 = 4{\cdot}7 \text{ lbs. N.}$$

$NH_3 = 17$, molecular weight. $N = 14$.

$$\frac{4{\cdot}7 \times 17}{14} = 5{\cdot}7 \text{ lbs. of ammonia per ton.}$$

The weight of a cubic foot of ammonia is 316·77 grains.

Cannel coals generally contain less nitrogen than common coals. It is generally considered that Continental coals produce much less fixed ammonia than those in the United Kingdom. The nitrogen in coal may be reckoned as distributed thus—

As ammonia	14·50 per cent.
As cyanogen	1·56 „
Free in gas, and combined in tar	35·26 „
Coke	48·68 „
	100·00

Mr. Lewis Thompson recommended that a small percentage of ammonia should be left in the gas, to combine with the sulphur compounds and produce sulphate of ammonia, as being likely to have a sanitary influence. Owing to the reduction of sulphur compounds, and the increased purity of the gas now issued from gas-works, it is undesirable in every way.

Conclusion.—Failing a continuous process of purification in closed vessels, it is most desirable to get as large a percentage of purification as possible done in the existing closed vessels, such as have been enumerated. A good deal more could be effected by liquid purification than is generally accomplished; and this principle was generally recognized in the early days of gas purification. It will be remembered that some forty or fifty years since a solution of sulphuric acid was used for purification; but the "acid boxes" have become extinct, on account of the affinity of sulphuric acid for the hydrocarbons. It is probable that a return, in some improved form, will be made sooner or later.

The author realizes that the foregoing remarks are but a trifling contribution to a most important subject.

As the paper (which was illustrated by diagrams and models of different designs of plant) was taken as read, it only gave rise to a few desultory remarks. At their close,

Mr. HARMAN said it was only natural that differences of opinion should prevail; and probably each member had

some pet theory as to the best system of purification. More particularly was this the case with regard to washers and scrubbers; and he hoped the suggestions he had made would be received in the spirit in which they were offered —that of inquiry. The importance of an efficient treatment of the gas in these preliminary stages of purification was very great, affecting materially all the subsequent operations. But scant justice had been meted out to numerous designs, principally on account of the limited time at his disposal. The subject of the greater use of wet reagents for complete purification was an extensive one; and a whole paper might very well be devoted to it. With regard to the sizes of apparatus employed, he felt sure that due regard was not always paid to the calculations necessary to ensure correct capacity in the plant. Some such method as he had indicated would perhaps be of service in determining not merely the cubic contents of the apparatus, but its actual working efficiency, which should be the dominant factor. The chemical changes that took place in washers and scrubbers were numerous; varying with different liquors and temperatures. In fact, so largely was the subject a chemical one, that it would be well worth attention and investigation by expert chemists.

THE THEORY OF THE INCANDESCENT GAS-LIGHT.

The catalytic theory of the action of the Welsbach mantle, expounded by Dr. H. Bunte, in his paper on "Incandescent Lighting, Acetylene, &c." (*ante*, pp. 398, 477), has recently been criticized by Dr. G. P. Drossbach, of Deuben, who offers a purely physical explanation of the action of the mantle.

He states that every source of heat has its characteristic heat-spectrum, of which the temperature maximum can have the most varying position; and that, as a rule, the higher the temperature the more is the heat maximum pushed towards the violet end of the spectrum. Snow observed that the electric arc light showed the maximum heating effect in the ultra-violet portion. The bunsen flame emits heat rays, of which a portion are in the visible and perhaps even in the ultra-violet part of the spectrum. The question is, How is the conversion of heat vibrations to light vibrations by an incandescent body in a non-luminous source of heat to be conceived? The kinetic energy of the molecules of gas is chiefly transferred by direct impact to the molecules of the solid. The solid body will only emit the most energetic luminous vibrations when the exciting heat vibrations are synchronous, or—to borrow an analogy from acoustics —when the latter include the overtone or harmonic of the former. In the incandescent gas-light, the bunsen flame emits the heat vibrations, which set up secondary vibrations in the molecules of thorium oxide in the mantle, while the particles of cerium oxide bring the two sets of vibrations into unison. In other words, the molecule of cerium oxide brings the heat vibrations of the molecule of thorium oxide to the most favourable state of resonance with the vibrations of the hot gases of the flame.

In order to substantiate his views, Dr. Drossbach carried out some researches, of which he gives an account in the "Journal für Gasbeleuchtung." Seeing the great effect produced by a very minute quantity of cerium oxide, it was evidently essential that the chemicals employed in the research should be of a high degree of purity in order to exclude the effects of minute quantities of foreign substances. Therefore, Dr. Drossbach proceeded to a careful purification of some commercial cerium nitrate, since that salt is by no means pure. Commercial thorium nitrate, on the other hand, is of a high degree of purity. Having obtained these two salts in a sufficiently pure state, he made (with carefully purified cotton gauze) mantles containing from 0·1 to 1·2 per cent. of cerium oxide, and then tested their illuminating power. The maximum illumination was observed when the mantle contained about 0·9 per cent. of cerium oxide. The following are the more important results of observations with different mantles:—

Percentage of cerium oxide	0·1	0·5	0·7	0·8	0·9	1·0	1·1
Illuminating power, candles	20·0	50·0	70·0	87·0	140·0	95·0	83·0

As much as 170 candles illuminating power was found in some cases with the mantles containing 0·9 per cent. of cerium oxide, and 140 candles was well within the average. So high a result with the ordinary bunsen burner appears quite unusual.

The use of zirconium oxide, or some other oxide than that of thorium, as a support or carrier for the cerium oxide, does not give similarly good results; and this fact throws doubt on the supposition that the chemical action of the cerium oxide has any part in the emission of light. Much stress has been laid on the voluminous character of thorium oxide as obtained from the nitrate; but a very dense oxide may be made from the sulphate, and equally good results obtained with it. But if, therefore, the surface area of the thorium oxide has no influence on the light, while that oxide cannot be replaced by some other without the light being affected, it follows that the cerium oxide cannot be chemically active in the combustion, but that the thorium oxide plays an important part, and that its physical properties are altered by the cerium oxide.

This view is substantiated by consideration of the many well-known cases in which small quantities of foreign substances alter the properties of a material. Thus 1 to 1·5 per cent. of carbon changes iron into steel, which has very different physical properties. Similarly the cerium oxide may be united chemically with the thorium oxide, and the compound have a greater power of emitting light than the thorium oxide alone—just as lime emits more light than does magnesia. It is quite unnecessary to attribute special influence on the combustion to either material, since the light emission depends solely on the vibrations set up by the molecules of the incandescent body. With the bunsen flame, there are a certain number of vibrations and a certain wave length; and the mantle is required to set up vibrations in unison, and by interference raise the amplitude of the vibrations of the molecules of the ether. On this the illuminating power depends; just as colour depends on wave length. Therefore a body emitting yellow light can give a much higher illumination than one emitting violet light, though the latter sets up more vibrations in unit time.

With regard to Dr. Bunte's attempt to raise thoria-ceria mantles to incandescence in the absence of combustion, Dr. Drossbach thinks the temperature of the bunsen flame could not have been attained: as the fire-clay or porcelain on which the mantles were placed would have melted at that temperature. Magnesia mantles shrivel up to small dimensions when placed in the bunsen flame. Moreover recent experiments show that the rare earths can be raised to incandescence by the electric current, with which there can be no question of chemical action.

To Dr. Drossbach's criticism of his researches, Dr. Bunte has given a brief reply, in which he points out that it was clearly stated in his paper that he used a tube of arc carbon, and not one of porcelain (*ante*, p. 398). The temperature attained in the tube was certainly far above that of the bunsen flame, as porcelain was rapidly melted and the prisms of magnesia were very much shrunken. Dr. Bunte further points out that the researches of Welsbach which have culminated in the invention of his electric lamp (*ante*, p. 879) in no way discredit the contact-theory of incandescent gas lighting, since only by using extraordinarily high temperatures does Welsbach bring the materials of his electric lamp filaments to intense incandescence.

The Action of Coal Gas on Storage Cylinders.—A curious experience illustrating the action of compressed coal gas on the metal of a compression cylinder was recounted in a recent number of "Nature" by Mr. C. E. Ashford. He states that a 40 cubic feet cylinder was filled with coal gas at a pressure of 120 atmospheres by a London firm in March, 1897. A small quantity only was used, and the cylinder stood until the 9th of October. It was then used for a mixed jet, and at the end of half an hour the light began to decrease; and in another quarter of an hour the flow of gas ceased. On re-lighting, the light was found to be perfect; so that the blame was laid upon the regulator. The cylinder was again used on the 5th of March last, and again after half an hour the light began to fail; but on turning the taps full on, "something audibly blew out of the muzzle," and the light was perfectly restored. The lime blackened excessively; while white hot, the oxygen alone was turned upon it, when the deposit became a brilliant red. The coal gas was then passed through a glass tube gently heated by a bunsen flame, with the result that a copious metallic mirror, which gave the test for iron, was formed. Hence it was considered that the jet had been choked by the decomposition of iron carbonyl at the high temperature. Thus it was concluded that there is an obvious disadvantage in storing for a considerable time compressed coal gas in steel cylinders, altogether apart from the possible damage to the cylinders, which has been shown to be small.

The Temperature and the Strength of Metals.—Some experiments have recently been made at the Royal Technical Institute at Charlottenburg in order to determine the effect of temperature on the strength and other physical properties of certain metals. The materials tested included iron, open-hearth steel, copper, samples of delta metal (both cast and forged), and finally manganese bronze containing different proportions of manganese. To secure uniformity in the results, the specimens for a series of experiments on any particular metal or alloy were cut from a single bar. First, the tensile strength of every material was ascertained at ordinary temperatures, and then at 212°, 392°, 572°, and 752° Fahr. These temperatures were maintained, while the specimen was being tested, by means of vapour jackets, or baths. The conclusions arrived at by the experimenters were that iron should not be forged or wrought in any way at a lower temperature than 572° Fahr., while in the case of open-hearth steel the working heat should be still higher. The same temperature is safe for working cast delta metal; but for the forged metal a higher temperature is necessary. The manganese bronzes stood remarkably well up to a temperature of 482° Fahr.; and this alloy is declared to be very suitable for warm work, since it is as strong at 392° Fahr. as at ordinary temperatures. The best alloy of the class appeared to be that containing between 5 and 6 per cent. of manganese; and this is therefore recommended as the most suitable for use in practical engineering work.

ESSAYS, COMMENTARIES, AND REVIEWS.

GAS AND WATER COMPANIES IN THE STOCK MARKET.

(For Stock and Share List, see p. 1588.)

THE state of the Stock Exchange is something remarkable. Quiet is not the word for it. Utter stagnation is scarcely too strong; and, so far as appearances go, one might imagine it to be the deadest period of the holiday season. The long nineteen-day account coming at the close of the half year has a good deal to do with this. But there seems to be a general disinclination to operate in anything; even the marked cheapness of money has failed to stimulate the gilt-edged market. Things will probably be more animated when we get into July, when there will be more money demanding investment. As might well be expected, prices have varied but little during the week; changes being for the most part measurable in fractions. The Money Market continues quite overloaded—the supply is largely in excess of the demand; and it is difficult to find any employment for money. The general apathy of the Markets was fully shared by the Gas Department, where business has been of the most limited proportions. There was no life in anything; and a general state of dulness and weakness depressed prices all round. The result is that all changes of quotation show a reduction in values, without a single advance to break the uniformity of the fall. In Gaslights, the "A" was lightly dealt in; and the price shrank away, until on Thursday it marked as low as 290. But it rallied slightly later on; and the closing mark on Saturday was 293—the quotation having only receded three points. The secured issues attracted more attention; and transactions in them preponderated. But the prices gave no indication of any change; being a good medium average. South Metropolitan was almost inanimate; very few transactions being marked. The ordinary was firm and steady; but the debenture eased down a point. Commercials were quite dead; not a bargain being done in them. The Suburban and Provincial group were far from being brisk; but there was more business in them than in most. Weakness was the characteristic; and Brentfords, Brighton, and Alliance suffered a reduction—the first-named having the worst of it. The Continental Companies were as quiet as the rest. Imperial and European were steady; but Union had a further fall. Among minor undertakings, Malta and San Paulo were fractionally lower. The Water Companies were fairly active considering the general slackness, and the tendency was good, especially in the debenture and preference stocks.

The daily operations were: Business in Gas was very quiet on Monday; and prices drooped all round. Brentford old fell 10; ditto new, 2½; Brighton, 2; and San Paulo, ½. In Water, Southwark rose 3½. Tuesday was just as dull a day; and Gaslight "A" dropped 1. In Water, West Middlesex 4½ per cent. debenture gained 2; and Southwark debenture, 1. Gas was quite inanimate on Wednesday. South Metropolitan debenture relapsed 1. Thursday was about the deadest day of the week. Gaslight "A" fell 2; and Malta, ½. In Water, Southwark "D" rose 3. There was a little more business doing on Friday; but nothing moved. Saturday was dull. Alliance fell ½; Continental Union, 2; and ditto preference, 5. In Water, Lambeth tens advanced 1.

HINTS ON COAL CARBONIZATION AND FUEL-GAS UTILIZATION.

BRIEF mention was made in the Editorial Notes of the "JOURNAL" for the 10th ult. of the meeting of the Iron and Steel Institute, at which papers touching upon gas matters were read by M. Adolphe Greiner, of the John Cockerill Company, and Mr. John H. Darby, of Brymbo. The contribution of the latter was in response to a request by the President of the Institute, who desired to have a record of the latest intelligence respecting the progress of coke manufacture with recovery of bye-products, and applied to Mr. Darby as a specialist in this line. It is unnecessary to explain how particular is the interest of this technic for the gas engineer, who has even been recommended to remodel his own traditional method of carbonizing coal in small charges, in accordance with the later coke-retort practice. We now revert to Mr. Darby's paper with the object of extracting from it whatever may be found to throw additional light on the problems of carbonization of coal in bulk. The author begins by admitting, as freely as the greatest stickler for the old practice could wish, that well-made beehive coke leaves little to be desired as regards blast-furnace working. He proceeds to show that well-made retort coke is economical in the blast furnace; and furthermore that coals which will not coke satisfactorily in beehive ovens will produce a marketable coke in retort ovens. It is recognized that there has been a good deal of prejudice against retort coke, for which there is little reason. In discussing this point, Mr. Darby brings out a consideration which is common ground for makers and users of metallurgical and gas coke. He observes that retort coke is often alleged to contain more water than beehive coke, owing to its being watered or quenched outside the oven. Upon this he states that he "has seen contracts for coke carried out where it was undertaken that the water and ash added together should not exceed 12 per cent., and where for months together no deduction was made for excessive percentage. Nine to ten per cent. of ash is a fair average for good coke; so very little room is left for water."

Retort coke is not of so bright appearance as beehive coke, and is of a different shape, both of which facts go against it in comparison with the older product. But the retort coke pays better to make. It is a business requiring greater capital outlay, and would not appear to be practicable except on a large scale. Mr. Darby says that a retort-oven to produce 25 tons of coke per week, with full complement of chemical plant to recover the products—tar, sulphate of ammonia, light oil, 90's and 50's benzols, and solvent naphtha—will cost about £800 when fifty are erected together. The practice in retort-oven construction has now settled down upon a model sketched by Mr. Darby. "They are long, narrow, horizontal chambers, in some cases 33 ft. long, and as high as the refractory material employed will stand—a convenient height being about 5 ft. 6 in. The width of the ovens is varied to suit the coal under treatment. As a general rule, highly bituminous coals require a wide oven, and consequently comparatively slow coking, to get the best results. Coals low in volatile matter require quick coking, so as to produce a hard coke." The widths in the author's experience vary from 13 to 20 inches. The proper width must be determined by experience. It may be inquired here whether any gas engineer has ever carried out a systematic study of retort shapes and sizes along the line indicated by the last observation? We do not for the moment recall any paper thoroughly treating the subject. It may be commended to the attention of gas engineering students.

Gas makers are unhappily familiar with the trouble of wet charges. This nuisance occurs in an aggravated degree with coke retorts, in consequence of the almost universal practice of washing the coal, which leaves from 11 to 20 per cent. of added water behind, even if the coal is allowed time to drain. Mr. Darby calculates the loss of heat due to the added moisture, and shows that with the common addition of 12 per cent. of water, there is carried away out of the retort 2·7 times the quantity of heat taken off by the whole of the gas evolved. It would not be desirable to coke a coal which is absolutely dry, even if it were possible; because a certain proportion of water with some coals seems to be advantageous to the quality of the coke produced—another point for the gas manufacturer to notice. But too much wet is a source of very great loss in a variety of ways, which need not be particularized.

According to Mr. Darby, apart from the question of dimension, the points to be observed in the design and construction of a retort-oven with recovery of bye-products are: First, possibility of examining all parts of the oven, so far as possible; second, that it should be possible to observe the heating-flues on either side, so that the regulation of the gas and air supplies can be properly controlled; third, the highly-heated lining should be independent of the main structure, so that it may be renewed when necessary, and not used for carrying the upper part of the structure. Inasmuch as the whole efficiency of a recovery oven is dependent on the fact that all the gas evolved from the charge is drawn off and treated for its products before being returned to burn in the heating flues of the oven, it is of the utmost importance that the flues should be preserved from "short circuiting." This is why ovens with horizontal flues are preferred by Mr. Darby to those with vertical flues, which are not open to inspection.

Of course, the prospects of retort ovens in the metallurgical coke trade depend upon the state of the residuals markets; and Mr. Darby discusses this part of the subject in a hopeful spirit which gas managers in general would be glad to be able to share. As regards tar and its principal constituent, pitch, the author somewhat airily remarks that the demand for these products "is likely to increase very considerably." He takes the yield of tar at 4·75 per cent. by weight of the coal coked, and prices it at 17s. per ton. This is too much by 30 per cent. Neither is light oil worth 7½d. per gallon. On the other hand, sulphate is proving, for the time being, a better market than he reckons for. Of the total sulphate production of the United Kingdom, which is stated at 198,280 tons for 1897, not 10,000 tons was the output of coke-ovens. The great bulk of the product, 132,724 tons, came from gas-works; so that the gas industry is as yet far from feeling the rivalry of other producers of the article. Moreover, there is room for any amount of it, to replace nitrate of soda. And sulphate making at present prices is a profitable business; for, as Mr. Darby points out, if the product has fallen in value of late years, so has sulphuric acid, which represents at least 50 per cent. of the cost of manufacture. Besides, as he might have said, there has been for the same period a great improvement of sulphate plants, in respect of economical working. He notices, as a factor tending to maintain the value of sulphate, "the tendency of gas-works to extend by water-gas plant without production of ammonia."

With regard to the commercial prospects of tar products, Mr. Darby seems to think a good deal of the possibility of using benzol for enriching gas. He says: "I have it on very good authority that one volume of benzol is equivalent, from an enriching point of view, to nearly 2½ volumes of light petroleum spirit. Therefore, a gas-maker could afford to pay nearly 2½ times the price of light petroleum spirit from 90 per cent. benzol

for enriching purposes. When it can be obtained at this figure, the consumption of benzol will be almost unlimited." This condition is already fulfilled, with benzol 90's at 1s. per gallon; but the demand for it is still reported "flat." It is not at all evident that Mr. Darby's forecast of the course of development of gas enrichment will be justified, if only by reason of the increasing popularity of enrichment by the carburetted water gas, which he mentions in another connection. On the whole, having regard to the heavy capital required, and the additional trouble involved, is it so certain that bye-product coke-ovens are so great a boon to the metallurgical coke manufacturer? There is nothing in the paper to encourage the idea that coal carbonizing in bulk is a cheaper proceeding than carrying out the same operation according to ordinary gas-works methods. He allows a charge of 1s. 9d. per ton for "labour, stores, &c.," which does not compare too favourably with the strictly carbonizing charges of a modern gas-works.

M. Adolphe Greiner's paper dealt with the utilization of blast-furnace gases directly for the production of motive power. There is a paper in the current number of the "Engineering Magazine," by Mr. W. H. Booth, on the utilization of blast-furnace gases as carried out at the Wishaw works of the Glasgow Iron Company; but this is on an experimental scale. In Scotch iron-works, however, the fuel employed is coal, so that there are residuals to be recovered. In Belgium, as in England, the fuel used in the blast-furnaces is coke; and the only possible way of saving anything out of the products of combustion is to treat the furnace as a gas producer—which it really is, and of a highly efficient order. At Seraing, the blast furnace gas, resulting from an average consumption of one ton of coke to a ton of pig, have an average calorific value of 987 calories per cubic metre. The average output of the furnaces is 600 tons of pig iron daily. It is agreed that the average gas production amounts to 4500 cubic metres (158,924 cubic feet) per ton of iron. Nearly one-half of this gas is at the present time used under the boilers, and the remainder is accounted for by the stoves, and leakage. It has been calculated that after providing all the power necessary for running the blast furnaces, there will be a surplus of 12,000-horse power, which might be utilized by means of gas-engines. M. Greiner, after discussing the *pros* and *cons* of the matter, sums up the advantages accruing from the use of gas as follows: "Gas is, above all other means, the most suitable for the transmission of power. In a factory where motive power is required at scattered points, there are many advantages in a central producer plant from which gas is led to gas-engines at the requisite places. Blast-furnaces are gas-producers ready to hand, and when there are two or three together, there is not much danger of very great variations in the quality of the gas. Gas can be supplied with ease under a low pressure, and without appreciable loss by leakage or condensation, to considerable distances. The mains and pipes are simple, light, and economical. Boilers and the dangers accessory to their use may be abolished. Gas shares with electricity the advantage of directly giving light, heat, and power; and this alone is sufficient to ensure its use by manufacturers." The testimony of the suitability of gas for transmitting power is worth placing upon record.

OBITUARY.

Mr. Henry Matterson, who has for many years been the Chairman of the Coventry Corporation Water Committee, died last Tuesday. Deceased, who was 73 years of age, had been in failing health for some months.

We have to record the death of Mr. R. Townend Martin, the Superintendent of the Rivington Water-Works of the Liverpool Corporation. Deceased, who had for some time been a sufferer from influenza, was 60 years of age, had been in the service of the Corporation about thirty years, and had held the position of Superintendent at Rivington six years.

Mr. James Peto, J.P., of Lowestoft, one of the Directors of the Lowestoft Gas and Water Company, died last Friday week, from heart failure, at the age of 82. The deceased gentleman was a brother of the late Sir Morton Peto, who has been described as the maker of Lowestoft. Mr. Peto had been a Justice of the Peace for forty years, and was Chairman of the County Bench at Lowestoft for about half this period.

The death is announced of Mr. Joshua Garside Wilson, a prominent woollen manufacturer of Rastrick. Deceased was a native of Lindley, near Huddersfield, and had carried on business at Rastrick for many years. At one time, he was Chairman of the Rastrick Local Board, and he was also actively connected with the Rastrick Gas and Water Companies. For some time he had been in failing health, and confined to his room; and his death occurred in his 78th year.

Mr. T. Dyne Steel, M.Inst.C.E., a well-known mining and railway engineer, died at his residence, Newport (Mon.), on Monday last week, at the age of 75. Mr. Steel had had considerable practice as a gas and water engineer, having designed and constructed gas-works at Brynmawr, Blaina, Abertillery, Abercarn, Risca, Pontymister, Cwmbran, Blackwood, Aberavon, and other places; and water-works at Crumlin, Newbridge, Abercarn, Abertillery, and Usk. In 1894 he designed water-works for the Blaenavon Local Board. In 1871 he was elected President of the South Wales Institute of Engineers, and held the position for two years, having been Vice-President for two years previously.

It is with considerable regret that we have to announce the death of Mr. Edward Fottrell, J.P., who for close on a quarter of a century had occupied the position of Chairman of the Alliance and Dublin Consumers' Gas Company. He was appointed to this office in 1874, in succession to Mr. Denis Moylan; and he continued down to the time of his death to discharge with energy and ability the duties appertaining to it. Even as recently as the 15th inst., he was present at a Board meeting, and appeared to be in good health. He, however, expressed the intention of going to the West of Ireland for a few days' rest and change. He passed away on the 20th inst., at the Great Western Hotel, Mullranney, Co. Mayo. Mr. Fottrell was for many years a prominent man in Dublin mercantile life; and, among his public offices, he filled for a long period the position of Chairman of the Rathmines Commissioners. His loss will be keenly felt by those who had the pleasure of his acquaintance, or who were brought into association with him in business matters. His kindly and genial disposition gained for him a host of friends; and the courtesy which marked his dealings with even those who were brought into casual relationship with him was universally recognized.

On Sunday, the 19th inst., Sir James N. Douglass, F.R.S., the late Engineer-in-Chief to the Trinity House, died at his residence at Bonchurch, Isle of Wight. Deceased will be remembered by many of our readers as the inventor of the high-power lamp bearing his name, as well as in connection with the experiments with lighthouse illuminants carried out some few years ago at the South Foreland. He was born at Bow in 1826; and, after receiving efficient training in civil and mechanical engineering, he became assistant to his father, who was Superintending Engineer to the Trinity House. He was afterwards appointed Resident Engineer in sole charge of the erection of the lighthouse on the chief rock of the dangerous group of The Smalls, off Milford Haven. In 1862, on the death of Mr. James Walker, F.R.S., the Engineer-in-Chief to the Trinity House, Mr. Douglass was appointed to succeed him. During his tenure of the post, he carried out many important engineering works both at home and abroad; and he effected numerous technical improvements connected with lighthouses and their illuminating apparatus, as well as in buoys and beacons. On the completion of the present Eddystone Lighthouse in 1882, he received the honour of knighthood. Sir James Douglass was strongly in favour of oil as the illuminant in lighthouses. The Commissioners of Irish Lights, on the other hand, advised by the late Professor Tyndall, were equally strong advocates of Mr Wigham's gas system. It will be remembered that a warm controversy arose upon the matter; and ultimately, in 1883, Professor Tyndall resigned his post of Scientific Adviser to the Trinity House and the Board of Trade. Sir James Douglass was elected a Fellow of the Royal Society in 1887; and early in 1892 he retired from his post at the Trinity House owing to ill-health.

PERSONAL.

Mr. W. White, of Penicuik, has been appointed Manager of the Renton Gas-Works, in place of Mr. J. Baxter, who has gone to Berwick to succeed Mr. S. Black.

The Cuckfield Rural District Council have appointed Mr. F. W. Dobson Manager of their water-works, which have lately been acquired from the Mid-Sussex Water Company, of which Mr. Dobson was Manager and Secretary.

Mr. J. T. Byrom, who has obtained the appointment of Manager of the Yarm Gas-Works, was lately presented with a gold-mounted walking-stick by the employees at the works he is now leaving, as a token of their good feeling towards him.

Mr. A. Thomas has resigned the managership of the Cowes Gas-Works; and Mr. W. A. Winter, of Oldham, has been appointed his successor. An arrangement has been entered into by which Mr. Thomas will visit the works at least once a month, or as often as requested by the Committee.

Mr. John Miles has been chosen to fill the vacant seat on the Board of The Gaslight and Coke Company, caused by the death of the Hon. Henry Noel. Mr. Miles is a Director of the Brighton and Hove Gas Company, the Colney Hatch Gas Company, the New River Company, and the West Middlesex Water Company. He is also a trustee for bondholders of the Kansas Water-Works and Irrigation Company.

Mr. Thos. Newbigging has published, through Messrs. Gay and Bird, a collection of his briefer productions in the field of pure literature under the title "Essays at Eventide." It is not our province to review works of this class; but we can warmly commend this book to the reading of those who are sufficiently interested in the personality of the versatile author to desire to make his further acquaintance as a man of literary gifts.

Lamp-Black from Acetylene Gas.—According to "Engineer," acetylene gas furnishes lamp-black of very superior quality; and its use for the production of this material has been patented in France.

COMMUNICATED ARTICLES.

PHOTOMETRIC STANDARDS.

By W. GRAFTON, F.C.S., of Beckton.

(*Continued from p.* 1469.)

The experiments of which particulars were given in the preceding article reveal a great deal of knowledge, especially since they are working temperatures. In summer, we have often an inside temperature of 80°. On July 6, 1894, it was 84½°; on Aug. 22, 1895, 83°; on June 16, 1896, 82°; on July 7, 8, and 9, 1896, 81°; on July 14 and 20, 1896, 82°; and on July 21, 1896, 83°, as registered by the thermometer on the meter. In winter, the temperature is often approaching 50° in some of the testing-stations; and to further show that the temperature of a testing-station, regulated under the very best possible conditions, does vary to some extent, the following figures for the years 1895-6-7 are recorded:—

TABLE III.

Hygrometrical Conditions of the Atmosphere at Testing House, Beckton Road.

[Observations of thermometers taken every half hour day and night. The figures are the monthly averages; also the grand total averages.]

Date, 1895.	Inside Conditions.				Outside Conditions.			
	Dry Bulb. Fahr.	Wet Bulb. Fahr.	Grains of H_2O in 1 Cubic Foot.	Humidity. Per Cent.	Dry Bulb. Fahr.	Wet Bulb. Fahr.	ns of H_2O in ubic Foot.	Humidity. Per Cent.
Jan.	60·6°	52·5°	3·40	56·8	33·1°	31·8°	1·88	85·7
Feb.	62·2	53·0	3·32	54·0	28·6	27·2	1·40	76·0
March	64·0	56·0	3·90	59·0	42·5	39·7	2·50	78·5
April	64·3	56·3	3·91	59·0	48·4	45·7	3·10	80·9
May	67·5	58·7	4·18	56·4	55·0	51·2	3·74	74·7
June	70·8	61·3	4·66	57·0	55·6	51·8	3·76	71·4
July	72·4	63·7	5·10	59·0	62·8	57·0	4·32	70·2
Aug.	73·0	64·8	5·18	62·0	61·4	57·0	4·65	77·6
Sept.	71·7	63·6	5·24	59·0	60·7	57·5	4·82	80·0
Oct.	61·8	55·6	4·04	65·0	47·7	44·0	2·82	88·0
Nov.	63·3	56·6	4·17	65·0	46·6	45·7	3·52	92·1
Dec.	63·4	55·2	3·85	57·0	41·0	39·5	2·60	87·8
Average for the year	66·2°	58·2°	4·24	59·2	48 6°	45·67°	3·20	80·3

TABLE IV.

Date, 1896.	Inside.						Outside.			
	Barometer.	Thermometer on Meter.	Dry Bulb. Fahr.	Wet Bulb. Fahr.	Grains H_2O in 1 Cubic Foot.	Humidity. Per Cent.	Dry Bulb. Fahr.	Wet Bulb. Fahr.	Grains H_2O in 1 Cubic Foot.	Humidity. Per Cent.
Jan.	30·55	63·08	61·97°	54·14°	3·60	58·5	40·02°	39·0°	2·60	91·16
Feb.	30·39	63·29	62·43	53·60	3·45	59·0	40·50	39·5	2·65	90·05
March	29·59	63·09	62·20	54·90	3·90	61·0	46·10	43·5	2·89	81·10
April	30·25	63·80	62·05	55·11	3·90	61·5	48·30	45·0	3·00	79·50
May	30·30	65·80	64·70	57·52	4·00	62·3	53·00	49·5	3·50	72·70
June	30·04	73·25	73·30	65·30	5·59	62·2	63·30	57·3	4·32	69·00
July	30·19	74·10	73·50	65·20	5·50	60·3	64·40	57·4	4·28	66·50
Aug.	30·12	69·00	68·75	62·00	5·10	65·0	59·25	55 5	4·30	75·75
Sept.	29·87	67·50	68·00	62·00	5·20	68·0	57·00	54·0	4·20	81·00
Oct.	29·85	64·00	58·00	64·00	4·50	67·0	46·75	44 7	3·10	86·00
Nov.	30·24	63·10	63·10	56·50	4·12	64·0	40·00	38·1	2·40	85·00
Dec.	29·84	63·50	63·50	56·75	4·30	64·0	40·00	38·5	2·50	88·00
Average	30·093	66·126	65·625	58·42	4·43	62·73	49·885	46 8375	3·3117	80·48

TABLE V.

Date, 1897.	Inside.						Outside.			
	Barometer.	Thermometer on Meter.	Dry Bulb. Fahr.	Wet Bulb. Fahr.	Grains H_2O in 1 Cubic Foot.	Humidity. Per Cent.	Dry Bulb. Fahr.	Wet Bulb. Fahr.	Grains H_2O in 1 Cubic Foot.	Humidity. Per Cent.
Jan.	29·96	63·00	62·20°	55·00°	3·90	61·0	35·50	34·20	2·15	87·5
Feb.	30·19	63·10	63·00	56·90	4·27	66·5	43·25	41·10	2·72	82·5
March	29·75	63·10	62·80	56·60	4·20	65·0	44·80	41·00	2·50	72·0
April	29·92	63 90	63·90	57·20	4·20	64·0	46·10	42·60	2·70	79·0
May	30·05	65·50	65·36	57·86	4·20	61·0	51·31	46·32	2·90	68·0
June	30·10	70 87	70·91	64·50	5·50	67·0	60·12	55·34	4·20	73·0
July	30·10	73·70	73·40	65·80	5·65	63·0	63·50	57·10	4·30	67·0
Aug.	29·94	72·70	72·60	65·80	5 85	66·0	63·60	58·90	4·80	73·0
Sept.	30·07	67·10	67·30	61·40	5·07	68·0	56·60	54·20	4·40	85·0
Oct.	30·26	64·40	64·80	59·10	4·70	69·0	50·60	48·70	3·60	85·0
Nov.	30·29	63·30	63·90	58·90	4·60	68·0	46·10	45·00	3·30	92·5
Dec.	29·97	64·00	64·00	58·10	4·40	67·0	42·80	41·40	2·80	90·5
Average	30·04	66·17	66·18	59·76	4·71	65·6	50·35	47·15	3·36	78·7

In the ordinary way of testing, it is the day and evening temperatures which affect the testing-room most; and very wide extremes do exist in the official rooms as between summer and winter temperatures.

Firstly, then, we learn that at any particular temperature the degree of saturation depends upon the quantity of pentane in the carburetter.

Secondly, that time must be allowed in order that the pentane vapour carried over shall be of constant quantity. Proof of this is that on lighting up there is a surplus amount of pentane vapour carried over, which causes the standard to emit *less* light for the first few minutes; and as the carburetter settles down, the flame requires repeated adjustment. But after from 20 to 30 minutes, the light remains constant. The experiments clearly show that the standard portion of the flame is seriously affected by the quantity of pentane vapour present in the air. This alone accounts for Mr. L. T. Wright's abnormal readings in his Series A and B, given in a paper read in May, 1896.

Thirdly, that the air at any definite temperature can only carry a definite amount of vapour. It cannot be over-saturated any more by pentane than by moisture. There is a limit varying with the temperature.

Fourthly, that as the pentane is volatilized, cold is produced, causing a lowering of the temperature of the carburetter from 8° to 10°, depending upon the time the standard is allowed to burn when in the end of the photometer.

Experiments with Increased and Decreased Flame Behind Cut-Off.

Mr. Dibdin, in a paper on the "Standards of Light," mentions that he found by using pentanized gas or air the flame may vary "between the limits of 2½ inches and 4½ inches in height," and yet give "practically uniform results."

On the blue screens of the standard were gummed narrow strips of paper a quarter of an inch apart. The flame had a very regular tip; and the air being remarkably free from draughts, it was easy to set the height at any particular line. One operator adjusted the heights of flames, while another made the observations of the disc. The observer, not knowing what height of flame was used, simply called his readings out; and they were booked by the operator who fixed the flame. Every care was taken to set the flame accurately. The bar of the photometer (60 inch) was graduated into inches, tenths, and twentieths of an inch each way of zero, by sticking a paper scale over the ordinary one. The scale was also in the dark. With these precautions, they entirely did away with any leading effect direct reading of the scale might have had upon the observer. The standard of comparison was also a Dibdin standard, carefully set to see that no errors were likely to arise from this end of the photometer. The standard required no adjustment during the making of each series; and such series were not always made in regular order.

The experiments extended over three days, and are the results of many observers' readings, which represent the amount of light in standard candles passing through the aperture when supplied with certain lengths of flame.

TABLE VI.—*Power of Standard when Supplied with Different Flames.*

—	Flame top of Chimney.	4-in. flame.	3⅞-in. flame.	3½-in. flame.	3¼-in. flame.	Temp. of Room.	Barometer.
Feb., 1896.	9·549	10·103	10·168	10·283	10·412	nearly 61°	30·61
	3-in. flame.	2⅞-in. flame.	2¾-in. flame.	2½-in. flame.	2¼-in. flame.		
	10·467	10·418	10·208	9·761	9·527		

These results are as was expected, and prove that the height of flame cannot be altered without altering the light used as the standard.

Mr. Dibdin has given out an explanation why various lengths of flame do not affect the power of the standard; but is this explanation tenable? The experiments prove otherwise; and, further, a standard was carefully set with flames 2⅛ inches, 3 inches and 4 inches long, and by means of fine platinum wire passed up through the cones of burner and arranged like calipers, the points of which were fixed so as to just touch the flame at one inch above the steatite (the widest part of a 3-inch flame), the following results were obtained:—

(*a*) 2⅛-inch flame .. 3-inch flame .. 4-inch flame { widest parts of flame measured.

20·5 mm. .. 21·0 mm. .. 21·75 mm.

(*b*) Lengths of (absolutely and partially) blue portions of flame.

Flame Length.	Absolutely Blue Flame from Steatite.	Partially Blue Flame.	Absolutely and Partially Blue Flame from Steatite.
2⅛-inch	0·35-inch	0·40-inch	0·75-inch
3 „	0·40 „	0·42 „	0·82 „
4 „	0·45 „	0·50 „	0·95 „

These results have since been checked by photographic means. Diagrams W, X, Y, *Z* are reduced representations of the Dibdin standard flame behind the cut-off, and particulars are given under each likeness. The dimensions shown were taken from the negatives.

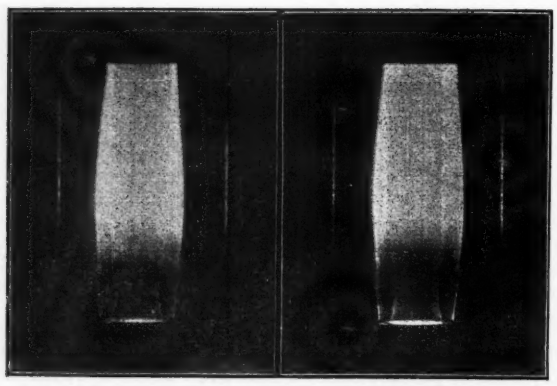


DIAGRAM W.
Dibdin Standard.
2·5 in. flame in chimney.
2·15 in. cut-off.

Length of blue portion $= \frac{37·5}{100}$ in.
Diam. at 1 in. above steatite . . . $= \frac{73·5}{100}$ in.
Diam. cut-off . . . $= \frac{57}{100}$ in.

DIAGRAM X.
Dibdin Standard.
3 in. flame in chimney.
2·15 in. cut-off.

Length of blue portion $= \frac{42}{100}$ in.
Diam. at 1 in. above steatite . . . $= \frac{75·5}{100}$ in.
Diam. cut-off . . . $= \frac{61}{100}$ in.

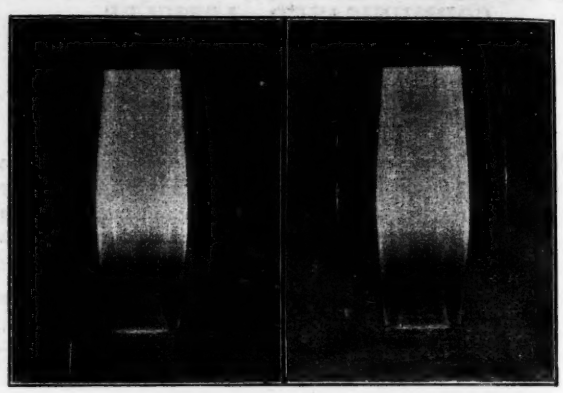


DIAGRAM Y.
Dibdin Standard.
3·5 in. flame in. chimney.
2·15 in cut-off.

Length of blue portion $= \frac{45}{100}$ in.
Diam. at 1 in. above steatite . . . $= \frac{76}{100}$ in.
Diam. cut-off . . . $= \frac{61·5}{100}$ in.

DIAGRAM *Z*.
Dibdin Standard.
4·5 in. flame in chimney.
2·15 in. cut-off.

Length of blue portion $= \frac{48·5}{100}$ in.
Diam. at 1 in. above steatite . . . $= \frac{76·5}{100}$ in.
Diam. cut-off . . . $= \frac{65}{100}$ in.

From these figures there is nothing like sufficient increase in the diameter of the flames to make up for any loss of light due to lengthening of the flame, and certainly no benefit accrues from having more flame in the chimney. The 3 inches is the critical point. Again, one-half of the increase in the diameter of the flame is taken farther from the disc, as well as the amount of white light taken upwards and wholly lost behind the cut-off; only goes to strengthen an argument in favour of variation or non-constancy in the standard. When, however, the flame falls short of 3 inches the diameter is reduced; and although there is less blue, there is less area of flame, and the latter is cooled down by an excessive supply of air.

(*To be continued.*)

THE GASHOLDER TANK AT SUTTON.

By F. S. CRIPPS, Assoc.M.Inst.C.E.

Gasholder tanks are made in such a variety of ways that, before entering upon any description in detail of the tank at Sutton, it may be of interest to point out the considerations which led the writer to adopt a burnt-ballast concrete tank for this place in preference to any other form of construction.

All kinds were carefully considered, with a view to determining the fittest and most economical. To do this, it was important to bear in mind the actual conditions existing at Sutton. The circumstances were these: The ground in which the tank had to be built consisted entirely of clay (if we except some 2 feet of top soil). Beneath the clay is chalk, but at such a depth as not to affect the construction of the tank; and from the experience gained in the construction of previous tanks at these works, it was inferred that there would be no trouble with water.

Under such favourable conditions for an underground tank, of course a *metal tank* was out of the question. And here I would say, wherever possible, even if it be somewhat more costly, an underground tank is preferable to an above ground one, and for these reasons: (1) A metal tank requires keeping in order by *painting* or tarring periodically, and is therefore a constant expense; whereas an ordinary brick or concrete tank will last out the life of any gas-works with scarcely any attention being required. (2) If a metal tank *bursts*, the consequences are disastrous (as at Constantinople, for instance, where the whole of the gas-works were swept away); whereas an ordinary underground tank is self-contained, and can do no damage to the rest of the works whatever happens to it. (3) A metal tank increases the height of the whole structure, which is objectionable for various reasons, particularly in some neighbourhoods.

A *Brick and Puddle Tank* was rejected because at that time bricks (although made locally) were at a prohibitive price—about 56s. per 1000. The writer considered the desirability or otherwise of the Company making their own bricks from the clay excavated; but this would have delayed the work, and would have been objected to by the Local Authorities, who oppose the starting of new brickfields.

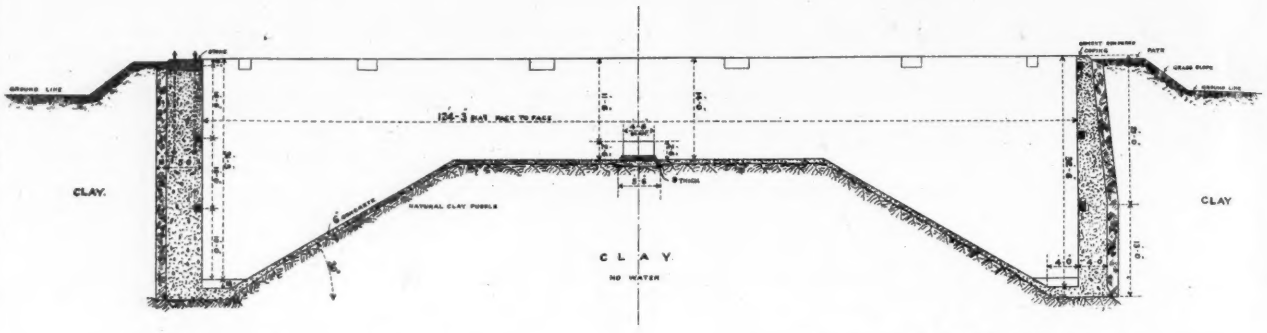
A *Concrete Tank* made of *ordinary ballast* (stones and sand) and portland cement was next considered; but as the materials would have to be carted some miles (and to get them by rail would likewise mean considerable carting, the gas-works being nearly a mile from the station), this was, after comparing the cost with the next mentioned, likewise rejected.

Burnt Clay Concrete Tank.—The clay to be excavated was known to be of excellent quality for making bricks, and therefore suitable for burning into ballast. Moreover, it would make

GASHOLDER TANK — SUTTON GAS-WORKS — Nº 6.

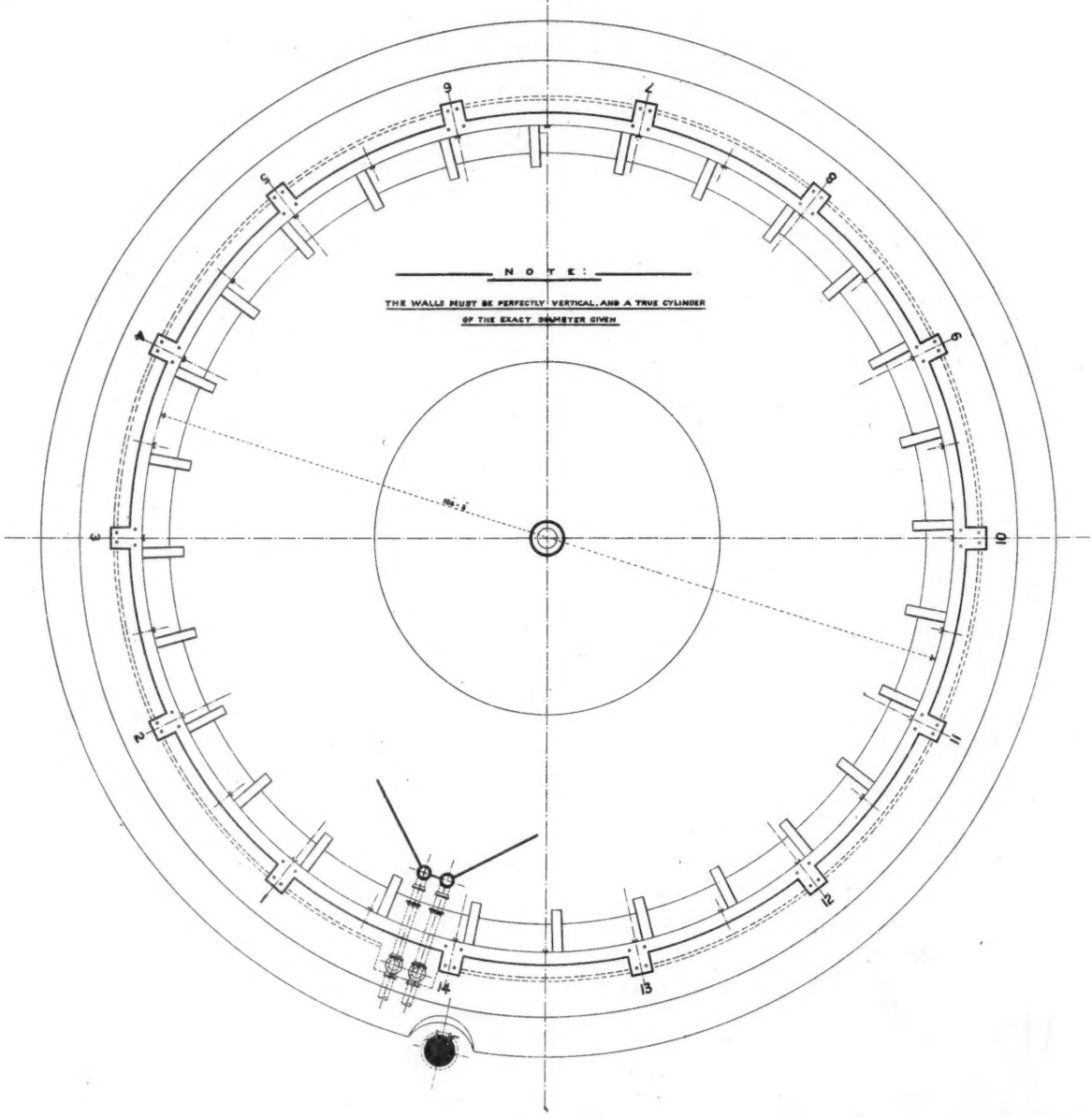
CONSTRUCTED OF CONCRETE MADE WITH BURNT CLAY BALLAST

SCALE OF FEET



SECTIONAL ELEVATION OPPOSITE STANDARD

SECTIONAL ELEVATION OPPOSITE INTERMEDIATE GUIDE



PLAN OF TANK

F.S.CRIPPS. A.M.I.C.E.
ENGINEER
(27 GREAT GEORGE ST. WESTMINSTER)

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splendid puddle. Hence, it occurred to the writer that considerable economy would result if the ballast for a concrete tank were made in this way.

The cost of burning into ballast is only about 2s. 6d. per cubic yard, as against at least double that amount which would have to be paid in Sutton for ordinary ballast. But the saving does not rest here. It must be remembered that the whole of the clay excavated, if not used, would have to be carted away some distance from the works at considerable expense. It was therefore highly desirable to use it, and so save as much of the expense of carting as possible. It was therefore decided to adopt this plan; the result proving eminently satisfactory, as the whole of the clay excavated from the trench was returned again in the form of concrete for the wall and cone, and as puddle behind the wall, instead of being carted away.

It may be asked why the inside face of the wall was not *rendered* water-tight, as is frequently done, to save using puddle. The answer is simply that the cost of the portland cement rendering would exceed the cost of returning the clay behind the wall in the form of puddle. A rendered tank is not so safe against cracks and leaks as a puddle tank. The wall would have to be made very much stronger to resist the bursting strain, if rendered; whereas with a puddle tank the water pressure comes upon the puddle behind—the concrete wall being made quite porous, so that the water may pass through it.

Other forms of tanks were considered, such as *casting the concrete into blocks;* but, apart from delaying the work, it would scarcely be so cheap or homogeneous as the monolithic plan adopted.

A *stone tank* was, of course, out of the question, as there is no stone to be obtained in the neighbourhood.

The description in detail, together with detail drawing of the tank, will appear in the next issue of the "JOURNAL."

TECHNICAL RECORD.

WESTERN (U.S.A.) GAS ASSOCIATION.

The Annual Meeting at Detroit.

(*Continued from p.* 1472.)

A paper on the "Prepayment Meter" was read by Mr. C. H. Raynor, of Adrian (Mich.), who had collected information on the subject from all parts of the States. The replies received showed about 45,000 of the meters in actual use, divided among 15 companies, of whom one alone had 30,000. The greater part were placed with the poorer classes; but they were also used for persons of doubtful credit, or to encourage the use of stoves. In all cases satisfaction was expressed with the results. The system was regarded as a new means of competing with electricity, and as a method of inducing the poor man to use gas more freely than he would do with the prospect of a quarterly bill in view. It was also looked upon as a means of encouraging the use of stoves, of catering for that large section of the public who buy by the pennyworth, which could not be got at in any other way, and of avoiding the need for demanding deposits in advance. In parts of New York, the landlords actually went to the Gas Company to arrange for the laying on of the system, finding that thus they increased the prospects of letting.

Discussion being invited, Mr. T. D. Miller objected to putting an extra price on the prepayment gas. The extra cost of the meter was covered by the saving of bad debts; and, if anything, the cash customer should receive a discount, and certainly should not be charged more. Prepayment meters could be used in connection with rooms in hotels and lodging houses. He had about 200 of these meters out, and had a corresponding number of canvass bags. When the collector went round, he put the contents from each meter into its proper bag, tied it up, and took it back to the office, where it was counted up and entered. This was better than counting up and booking at the consumers' premises, which led to inquiries as to how much was in the box. Mr. Butterworth had found that out of some 14,000 houses in his district, only about half used gas; and he had employed a staff of canvassers to solicit new customers, who were allowed as a last argument to offer prepayment meters. This secured 600 customers, of whom only 450 really continued to use gas; so that the experiment was not eminently successful. Mr. Dole had put in several prepayment meters; and they averaged 11,000 to 12,000 cubic feet per annum. He agreed that the extra cost of the meter was covered by the saving in collection, &c., and that there should be no extra rate, unless by special agreement to cover the cost, or pay by instalments for fittings. In this case, the extra tariff should cease when the fittings had been paid for. He intended to supply on this system at the regular price. Mr. A. C. Humphreys remarked that the prepayment meter should be set in a safe place. In some tenement buildings in New York, where they were placed on the landings, there was so much pilferage that the Gas Company had to insist on their being situated inside the apartments. Other speakers mentioned a few difficulties, none of an important character, in the matter of shortage of cash. Mr. J. T. Lynn said that in many American cities the price of gas was fixed by statute, and could not, therefore, be exceeded; so that an extra rate was out of the question. Mr. Harbison said that he, for one, would not countenance charging one consumer a different price than another. This was not the way to keep a reputation for uprightness. Also he did not like the idea that the prepayment meter was necessary as a means of saving bad debts. At Hartford, with 8000 consumers and 100 miles of mains, his bad debts for the last twenty years did not average 0·25 per cent. of the gross rental; so that he did not need the help of a new system.

Mr. T. D. Miller, of Dallas (Texas) gave an historical review of the progress and development of the gas industry in the State of Texas. It was first introduced at Galveston in 1856; and Houston followed ten years later. Jefferson, Austin, San Antonio, Dallas, Fort Worth, and other places soon took up the matter. Coal gas on the ordinary system was mostly used; but Lowe water gas, Pintsch oil gas, and wood gas were also supplied. At one time, the Indian territory mines were under one control, and the coal cost 16s. to 23s. per ton; but mining had lately been largely developed in the district, with the result that coal was about 2s. per ton less in price. Colorado and Pittsburgh coals were also brought by water. The Indian territory coals gave 30 to 38 per cent. of volatile matter, the sulphur was low, and the ash ranged from 3·5 to 6 per cent. Colorado coal gave more ash, but did not make a hard clinker; and the gas was 2 candles better quality. But the Texas coals proper were not of much value as gas coals; the sulphur being high, the coke poor, and the ash 12 per cent. There were several lignite deposits in the district, which would yield 5000 to 6000 cubic feet of 14-candle gas per ton; and one of these partook of the nature of a cannel, and yielded 11,000 cubic feet of 22-candle gas per ton. There were some supplies of natural gas at Brazos, Corsicana, and Calvert; but it was usually contaminated with nitrogen. These had been utilized in various ways—that at Corsicana having been mixed with Lowe water gas. Petroleum had been found at Nacogdoches thirty years ago, and lately at Corsicana, where the business had been developed. The wells were about 1000 feet deep, 60 in number, and yielded 900 barrels per day. The oil was mostly used as fuel; but the author employed it for making gas, and was able to keep up a good 20-candle gas with it. Some results of fractional distillation of the oil were appended. It had a specific gravity of ·820, and began to boil below 176° Fahr.

Mr. Bankson Taylor, of St. Pauls (Min.), read a paper on "The Ignition of Gas by Static Electricity," in which he related some experiences which go to show that a rapidly running belt on an exhauster or other machine generates a certain amount of electricity, which may, under favourable circumstances, give a spark strong enough to ignite an explosive gaseous mixture. It is not safe to open a governor or meter in the vicinity of such machinery while it is at work.

Mr. Shelton opened the discussion by stating his experience of a station meter being "blown up" while under repair. The cause of this was proved to be a spark struck by a workman's chisel. Mr. Egner supported the conclusions arrived at by the author. Some years ago he remembered charging an improvised Leyden jar from a large exhauster belt at the works of the New York Gas Company, and giving his friends a shock. Later, a man in charge of a dynamo machine used to get severe shocks, sufficient to knock him down, in a manner that could not be explained; and his New York experience enabled him to find out the cause and apply a remedy. Mr. W. M'Donald said that almost every meter manufacturer was aware that it was not safe to open a meter near a running belt. The author spoke of a quickly running belt; but a slow belt would sometimes give off electricity very freely, and the only safe plan was to stop it altogether. The station meter was particularly dangerous, because it would hold gas for days, and even weeks, after it had been disconnected. Mr. Faben suggested that the electricity was produced by the friction of the belt slipping on the pulley; and Mr. Witherby thought it was not so much the friction on the pulley as the friction of the atmosphere, as in a static electrical machine. Mr. T. D. Miller had charged his hand by holding it near a rapidly running belt, and given a friend quite a shock. He had also seen points put close to a large belt to conduct off the electricity.

(*To be continued.*)

THE DECOMPOSITION OF GAS OIL, PHENOL, AND CREOSOTE BY HEAT.

(*Continued from p.* 1473.)

Experiments with Creosote (continued).

Two other experiments with the same sample of creosote gave results which differed in several respects from those already obtained. The dissociation of the molecule was less thorough, the separation of carbon was smaller, and the make of tar was greater and its content of benzene much larger. In one of these experiments, 98 grammes of the creosote were gasified, and afforded 37,048 c.c. of gas. The specific gravity of the non-desiccated gas was ·638; and one litre weighed 0·8142 gramme. Owing to a leak in the apparatus, the gas contained 13·3 per cent. of air; and therefore the calculation of the composition of the air-freed gas and of the weight of the several components was omitted. The gas actually contained 36·5 per cent. of

carbonic oxide, 26·3 per cent. of hydrogen, 21·7 per cent. of methane, and 2·0 per cent. of ethylene. Tarry products collected in all the vessels up to the inlet of the gasholder. From these vessels 22 grammes of distillate (dehydrated) coming over below 248° Fahr. were obtained, and thence were isolated 17·37 grammes of benzene. Therefore 100 parts of creosote had yielded 17·73 parts of benzene. The carbon which separated in the gasification tube, for the most part resembled brittle coke; but there was also a little soot-like deposit. The gas contained 0·054 per cent. of acetylene. This was the last determination of acetylene in these researches, as it was considered that the experiments had completely established the fact that the formation of acetylene in the pyrogenic decomposition of the phenols was inconsiderable, and only the result of secondary reaction.

It was surmised that the difference between the results of this and of the two earlier experiments on creosote was due to a difference in the temperature of gasification. It was shown by a special test, in which the temperature was increased gradually, that the zone which intervenes between the temperatures at which the production of tar is heavy and that of gas light, and those at which the production of gas is great and that of tar small, is a very narrow one; and the temperatures used in the experiments were not far removed from that zone of demarcation. The fact that this limiting temperature was not greatly exceeded in the first two tests on creosote was confirmed by the results of a fourth test, in which the rate of supply of the creosote was increased while the other conditions remained unaltered. Altogether 148·5 grammes of creosote were admitted to the gasification tube in 2 hrs. 10 min.; and the temperature was depressed below that of the first two experiments owing to the greater rate at which the creosote was admitted to the tube. Carbon was separated in small quantity, and had the character of a product intermediate in nature between coke and soot. The production of gas was low, as the following comparison of the weight and volume of gas from 100 grammes of creosote, in the first and this (the fourth) experiment shows:—

—	First Experiment.		Fourth Experiment.	
	Grammes.	Cubic Centimetres.	Grammes.	Cubic Centimetres.
Carbonic oxide . .	21·94	17,567	14 68	11,737
Hydrogen	2·70	30,309	0 70	7,859
Me hane	8·25	11,578	7·78	10,875
Carbon	28·38	..	2·00	..

The thorough decomposition which took place in the first experiment is clearly indicated by the large quantity of hydrogen produced. The formation of nearly the same amount of methane in the two instances will be considered later. The amount of benzene obtained in the fourth experiment was 11 per cent. of the creosote gasified, which was a smaller yield than was found in the third experiment, but nevertheless was large. The results of the gasification of creosote may be thus summarized: (1) The process of dissociation of the cresols at temperatures between 1300° and 1470° Fahr. corresponds to that of phenol at like temperatures. The cresol molecule breaks up for the most part completely; forming permanent gases—carbonic oxide, hydrogen, and methane—and soot-like carbon, in accordance with the equation—

$$C_6H_4,OH,CH_3 = CO + 4H + CH_4 + 5C.$$

(2) The presence of a methyl (CH_3) group in the molecule promotes the reconstruction of the benzene ring after the removal of the carbonyl (CO) group from the cresol. Hence the large yield of benzene, which again appears to be dependent on variation in the temperature. (3) The large proportion of methane in the gas, compared with that observed in the gas from phenol, supports Haber's contention that small terminal groups are split off and form methane.

The third conclusion is clearly justified by the results of the first and fourth experiments on creosote. Though the decomposition in the one case was much less complete than in the other, nearly the same quantities of methane were obtained. This fact can only be explained by assuming that the methyl group is readily split off, and must have been so in the case of the majority of the cresol molecules even in the fourth experiment.

Experiments on a Mixture of Phenol and Gas Oil.

A mixture of equal parts of gas oil and phenol was made in the warm, as the phenol separated on cooling to the ordinary temperature. The mixture was run into the gasification tube in the same manner as the pure phenol. In 5 hrs. 50 min. 120 grammes of the mixture were gasified, and 47,704 c.c. of gas were obtained. The specific gravity of the dry gas was ·5764; and the weight per litre, 0·7361 gramme. A small glass spiral was used in place of the condensing tower; and therefore a smaller volume of air was mixed with the gas. The composition in volumes per cent. of the air-freed gas was as follows: Olefines ($C_n H_{2n}$), 14·9; carbonic oxide, 14·7; hydrogen, 35·3; and paraffins ($C_n H_{2n+2}$), 35·1. The paraffins according to the observed consumption of oxygen may have consisted of 1·07 volumes of ethane and 34·03 volumes of methane. The mean molecular weight of the olefines was 36·6. The total weight of the gas obtained was 34·1 grammes, which is 28·4 per cent. of the weight of material treated. There was obtained 66·5 grammes (55·4 per cent. of the raw material) of rather viscous tar, of which 9·5 grammes distilled off below 248° Fahr., and yielded 6·2 grammes of benzene. The distillate up to 392° Fahr. did not solidify at ordinary temperatures; but at 32° Fahr. some undecomposed phenol separated from it. The decomposition had, however, extended fairly uniformly to both constituents of the mixture. Carbon amounting to 2·3 grammes separated in the tube in the form of coke-like scales. The following are the parts by weight of products obtained by the gasification of 100 parts of the mixture: Gas, 28·4; benzene, 5·2; tar, &c., 58·6; carbon, 1·9. The loss amounted to 5·9 parts.

The photometric tests were in keeping with the analytical results. Several burners were used; but a 6 cubic feet batswing gave the best flame, and at a consumption of 5·297 cubic feet per hour the illuminating power was 9·9 candles. The results of the gasification of the mixture were intermediate between those of the gasification of the two components, except that the amount of carbon separated was less. Reference will be made to this point later.

A second experiment, in which the rate of admission of the mixture to the tube was more than twice as fast as in the first experiment, was made. In this, 185 grammes were gasified at the rate of 0·86 gramme per minute, and yielded 48,120 c.c. of gas, which weighed 0·9069 gramme per litre. Freed from air, the gas consisted of 31·3 per cent. of olefines, 12·5 per cent. of carbonic oxide, 17·9 per cent. of hydrogen, and 38·3 per cent. of methane. Altogether 123 grammes of tar were obtained; and from it 5·1 grammes of benzene were isolated, as well as 60 grammes of phenol—or more than two-thirds of that contained in the mixture gasified. The decomposition of the gas oil in the mixture had been more thorough than that of the phenol, from which circumstance it may be concluded that the decomposition of phenol requires a higher temperature than is necessary for the decomposition of gas oil. This conclusion is in conformity with the practical experience that gas oils containing phenol yield large quantities of tar. At a consumption of 5·297 cubic feet per hour in a 4 cubic feet batswing burner, the gas had an illuminating power of 31·13 candles. The flame was beautifully white. The gasification of a larger proportion of gas oil than of phenol from the mixture was apparent in the photometric results, and in the greater percentage of olefines. The illuminating power of the gas made in the second experiment was more than double that of the gas made in the first experiment.

Experiment on a Mixture of Creosote and Gas Oil.

The mixture consisted of equal quantities of creosote and gas oil. On cooling for a considerable time, crystalline laminæ of ortho—or para—cresol separated from it. An amount of 105 grammes of the mixture was gasified at the rate of 0·52 gramme per minute. The gas obtained amounted to 47,839 c.c.; and 1 litre of it weighed 0·8151 gramme. Freed from air, it had the following composition in volumes per cent.: Olefines, 16·9; carbonic oxide, 16·9; hydrogen, 25·9; paraffins, 40·3 (methane, 39·76; ethane, 0·54). The mean molecular weight of the olefines was 31·18; therefore homologues of ethylene were associated with it. From the tar, 9·7 grammes of benzene were obtained; and 0·4 gramme of glossy laminated carbon was found in the tube. The following are the parts by weight of the products from 100 parts of the mixture: Olefines, 10·8; carbonic oxide, 9·6; hydrogen, 1·0; methane, 13·0; ethane, 0·3; benzene, 9·2; tar and condensation products, 49·6; and carbon, 0·4. The loss amounted to 6·1 parts per cent. Separation of soot-like carbon did not occur; but the effect of the creosote on the products was very evident in the proportion of carbonic oxide, hydrogen, and benzene. The photometric tests gave results in keeping with those obtained in the first experiment on the mixture of gas oil and phenol. A 5 cubic feet batswing burner, at a consumption of 3·07 cubic feet per hour, gave an illuminating power of 8·3 candles.

This experiment brought the series to a conclusion. The following deductions were drawn: (1) Phenol and creosote may be gasified uniformly in conjunction with gas oil at temperatures of 1300° to 1470° Fahr., at the rate of about 0·3 to 0·5 gramme per minute, with a heating surface of about 46 square inches. The yield of gas from a mixture of gas oil and phenol or creosote is the same as from an equal weight of pure gas oil; but the illuminating power of the gas is very much lower, as the gas from the phenol or creosote burns with an almost non-luminous flame. (2) In such mixtures, the phenol or creosote molecule is not completely broken up. Carbonic oxide and a portion of the hydrogen only are split off; while the residue (which is rich in carbon) of the phenol or creosote molecule is absorbed by the constituents of the gas oil. (3) At a temperature a little below 1300° Fahr., the decomposition of the phenol ceases, while that of the gas oil persists; the phenol is only distilled. Hence gas oils containing phenol are found to give a large yield of tar.

(To be continued.)

Acetylene Gas Manufacture in West Prussia.—The Allgemeinen Carbic-Acetylen Gesellschaft of Berlin has secured a concession to establish and carry on, during a period of thirty years, an acetylene gas-works in the town of Schönsee, situated in West Prussia.

BRITISH ASSOCIATION OF WATER-WORKS ENGINEERS.

The author of the last paper read at the meeting of this Association at Southampton was Dr. PERCY F. FRANKLAND, of Mason College, Birmingham; and the opportunity of hearing this distinguished scientist discourse on a subject of which he is a master, attracted a full attendance of members. He entitled his paper—

THE CHEMICAL AND BACTERIOLOGICAL EXAMINATION OF WATER.

In the introductory portion, Dr. Frankland pointed to the fact that the duties of the water engineer showed no sign of becoming lighter with the march of time, and that, if the fastidiousness of the public in the matter of quality continues to increase in the future as it has done in the past, the position of the water engineer will become unenviable in the extreme. Dealing with the chemical examinations of water, he referred to the necessity of the analyst possessing the requisite experience and judgment to make, from the data he obtains, a more or less accurate diagnosis as to whether, and in what degree, water has been contaminated, or to advise whether it is of good, bad, or indifferent quality for the supply of the community. He particularly emphasized this—that the value of the analyst's opinion is greatly increased if he takes into consideration, and is able to carefully examine, the source of the water in question; and he commented on the absurdity of the practice of withholding from the analyst all information as to the source of the sample submitted to him. In inquiring whether a given water was suitable for the supply of a community, the method of examination, he said, which enabled the detection, with the greatest degree of certainty, of contamination is of most importance and value; and the method which best fulfils this requirement is still the chemical, which has done such signal service in improving water supplies. There are, however, many waters available in very large quantity which, although undoubtedly contaminated with sewage matters, are still contaminated to such a slight extent that they differ but very little in chemical composition from waters obtained from unimpeachable sources; and the question has early forced itself upon practical men, whether such waters must be wholly avoided or whether they cannot be rendered suitable for domestic purposes by submitting them to some simple process of purification, such as storage in large reservoirs or filtration through fine sand. But chemical analysis showed that these processes of storage and filtration did not bring about such a profound change in the composition of the water as to justify the idea that, by such treatment, a water which had received dangerous contamination would be deprived of its power of doing mischief to the consumer. The author here showed how comparatively slight is the effect of sand filtration on the chemical composition of water by citing analyses of the York water made by himself.

It was obvious that the resources of chemical science could not be expected to throw any decisive light on this important question as to the possibility, by purification processes, of rendering such waters as those referred to reasonably safe for consumption. But the new methods of bacteriological study (which were brought to a high state of perfection about fifteen years ago by Robert Koch) appeared at last to furnish the necessary machinery for prosecuting this investigation. It is now more than thirteen years since the author first applied the bacteriological method to the London Water Supply, with the result that the purification processes there practised were exhibited in an entirely new light. The investigation brought out the reassuring fact that the purification processes employed were often successful in achieving the removal of upwards of 98 per cent. of the bacteria present in the original water, as the following figures show:—

Average Number of Bacteria found in One Cubic Centimetre of Thames Water Supplied to London Before and After Filtration.

Month.	River. Thames.	Filtered.	Reduction, Per Cent.
January	92,000	129	99·9
February	40,000	447	98·9
March	66,000	428	99·4
April	13,000	91	99·3
May	1,900	60	96·8
June	3,500	65	98·1
July	1,070	34	96·8
August	3,000	21	99·3
September	1,740	56	96·8
October	1,130	25	97·8
November	11,700	85	99·3
December	10,600	116	98·9

These figures reveal the fact, which no chemical analyses could have ever discovered, that the risk attending the consumption of the filtered water is incomparably less than that which would be incurred in consuming the same water prior to purification. But more than this, the results disclosed the possibility of placing this and other purification processes on a sound scientific basis; and as early as 1886 the author was able to show, in a paper which he read before the Institution of Civil Engineers, that, among the several London Companies dealing with the same unfiltered water, those achieved the best average result in respect of the removal of bacteria whose water was stored for the longest period of time, filtered at the slowest rate, and through the greatest depth of fine sand.

Again, the bacteriological method of examination has enabled the exploration in detail of the mysteries of these purification processes, and the discovery of the precise points at which the removal of bacteria takes place. Thus the author was able to show for the first time in 1892, by means of experiments made at some of the London water-works, the bacterial purification which occurs in storage reservoirs. The number of bacteria obtained per cubic centimetre from samples of water was as follows: Thames water from Hampton, 1437; Thames water after passing through one storage reservoir, 318; Thames water after passing through two storage reservoirs, 177. The author drew attention to other confirmatory experiments on this point; and then showed that he had obtained like results in studying the process of sedimentation in natural lakes.

Another important fact connected with water-works filtration which has been revealed by the bacteriological method of examination is that a new sand filter, or a sand filter which has just been scraped, possesses but very little power of removing bacteria. A particularly striking example of the comparative inefficiency of a sand filter which had just been started after scraping came under Dr. Frankland's notice, in connection with the water-works of a large city, only this year, and is exhibited by the following figures:—

	Unfiltered Water. No. of Bacteria in one Cubic Centimetre.	Filtered Water. No. of Bacteria in one Cubic Centimetre.	Rate. Inches.	Age of Bed. Days.
January	639	78	3·6	36
February	3042	57	4·9	17
March	221	59	5·3	18
April	1300	528	3·1	1

It will be observed that in April, when the bed had only just been started, the efficiency of the filter was much less than on any of the other occasions, although the rate was the slowest. This comparative inefficiency of a new sand filter revealed by bacteriological examination, shows how necessary it is that the practice should be adopted of running to waste the filtrate until the sand has acquired the power of retaining the micro-organisms in the water—a practice which is at present, the author regretted to say, but little adopted by water engineers.

From the foregoing facts, Dr. Frankland said, it is obvious that the only available method of ascertaining whether filtration is being efficiently carried out is by submitting the water before and after filtration to bacteriological examination. It is, moreover, essential that the performance of each individual filter-bed should be submitted to this bacteriological control.

Just as the bacteriological examination has enabled the real value of artificial purification processes to be ascertained, so also by its means can it be discovered whether or not natural purification processes are operating with efficiency. Thus the safety of deep-well water depends upon the exhaustive filtration to which it has been subjected in the porous strata of the earth; and if the water gaining access to such a well has really been thus filtered, it should be almost entirely free from bacteria, and this in regard to properly constructed wells is found actually to be the case. It is desirable, therefore, that wells should be frequently submitted to the control of bacteriological examination; and this control is especially necessary after heavy rains, as it is at such times that there is the greatest possibility of the ingress of surface water taking place.

The author next pointed out that the results obtained in bacteriological investigations can only be of value if the samples have been collected in the proper manner, and with the exercise of sufficient judgment. Indeed, there are a number of details which unless rigidly adhered to may lead to the most erroneous results being arrived at. The water must invariably be collected in sterilized bottles, and be submitted to examination with the greatest possible dispatch; while, during any unavoidable delay, the samples should be packed in ice to prevent multiplication of the bacteria. Much discredit has already been brought upon the method through inattention to such details by persons who might have been expected to be better informed.

In concluding his paper, Dr. Frankland said that there is a class of persons, mostly belonging to the medical profession, who, with the introduction of bacteriological methods, began to cherish the idea that the examination of water would resolve itself into looking for the specific bacteria of diseases. The realization of this hope is, however, apparently as far distant as ever, for it is becoming daily more evident that the recognition of specific bacteria is a matter of much greater difficulty than was at first supposed; and the bacteria which are associated with typhoid and cholera are among those which offer the greatest obstacles to complete identification. That the bacteriological examination of water has hitherto disappointed the expectations of these persons is, in the author's opinion, of very little consequence; for the importance attributed by them to the possibility of discovering the specific germs of disease in any particular sample of water, shows that they do not in the least realize the perspective of the many points which have to be taken into account in the practical selection of water supply. He did not think it probable either that the water engineer is likely to take this distorted view of the primary object of water examination; for he knows full well that, in providing a supply of water, it is not only necessary that a particular sample of it submitted to an expert shall be free from danger, but that it shall be derived from a source which is capable of continuously

yielding, year in year out, a safe and wholesome product, and, in order to secure this end, he will have to make use of all the independent evidence which is available: Firstly, that which is obtained from careful inspection of the source; secondly, that which can be furnished by chemical analysis; and, thirdly, that which is afforded by the bacteriological examination of the water. And the special value of the bacteriological evidence will consist in the power possessed by this method of examination alone of revealing whether, and to what extent, any purification processes, natural or artificial, are able to remove from water disease-producing bacteria, should they at any time be present.

Discussion.

The PRESIDENT (Mr. W. Matthews, of Southampton) said the light Dr. Frankland had thrown on sand filtration was a matter on which water engineers generally had to offer him their greatest thanks. There was no doubt that he had raised the question from one of great uncertainty to what was more or less approaching an exact science.

Dr. KEMNA (Antwerp) agreed with all that had been advanced in the paper, but thought he was better qualified perhaps than Dr. Frankland to speak of the efficiency of sand filtration. He contended that in England water engineers did not know what a bad water really was. He had inherited a situation which was a very difficult one, having to supply the large city of Antwerp by a tidal river, which ran in a low, flat, and highly polluted country, and which had been turned into a most offensive sewer. The water was analyzed before and after decantation; and frequently at various periods of the tide of the river. In fact, he made something over 600 analyses a month; and it might interest members to know that his microbes cost him 5s. a week for beef. (Laughter.) He must confess, on looking at the figures referring to the water the London Companies had to deal with, he had an envious feeling. Those figures were very low; and if he compared the results with his ordinary daily work, he was afraid he would have to add one or two ciphers to them. The figures of the filtered London water were really very good; and he could not understand such a practical, business-like people as the English pretended to be making such a row, and sometimes in such a ridiculous way, over what he regarded as the splendid achievement of the Water Companies. He had been much struck with Dr. Frankland's work as to the influence of subsidence on water. He (Dr. Kemna) had tried to repeat his experiments on a large scale, with large subsiding tanks. But he had not always been able to obtain the same results; so that he concluded that subsidence had rather a different effect on different waters. It seemed to him that some of the results of filtration with London water were not really satisfactory, because a filter starting with 1000 microbes should give, if the filtration were properly conducted, certainly under 20 microbes. He could show at Antwerp water containing something like 20,000 colonies on a sand filter, and, after filtration, only between 15 and 20. The greatest care was, of course, taken with the filtration. He next spoke of the necessity of a constant rate of filtration; and, in starting a filter, he preferred that the rate should not be more than an inch, or, better still, that the water should remain at rest in it for six to twelve hours, so that a deposit might form on the surface. Sudden changes or shocks should be avoided; and the filters should be quite independent of varying consumption, which meant that sufficient storage for purified water must be provided.

Mr. A. ANGELL (Analyst for the county of Hampshire), speaking of the number of microbes that were permissible in water, said he wished to quote a statement by an eminent authority; and he did not think Dr. Frankland would refute it. It was made by his respected father (Sir Edward Frankland) in reference to the Grimsby water. He stated that the water was of a high degree of organic purity, and was in every respect of excellent quality for dietetic and most trade purposes, and that it contained 624 microbes per cubic centimetre. Except perhaps as a guide to water engineers, he (Mr. Angell) saw no value in counting these microbes. If they were allowed to have 624 microbes per cubic centimetre, they might be allowed to have any number. He also referred to the difficulties surrounding the collection of samples; the principal being that of selecting such a, comparatively speaking, minute quantity as should fairly represent the properties of the bulk. It was a risky thing. For instance, under a microscope, a minute flocculent particle floating in the water might be taken as one of the residents in a large colony of microbes. He did not place much value on the bacteriological examination of water. Dr. Frankland had spoken of water analysis as a diagnosis; and he agreed that the report of an analytical chemist on water submitted to him must be looked upon simply as such—as an opinion, and nothing more. It was very necessary the analyst should have a considerable amount of knowledge or experience as to the source from which the water was obtained.

Mr. C. H. PRIESTLEY was able to confirm, from his experience at Cardiff, what Dr. Frankland had said as to the value of subsidence; but, from Dr. Kemna's remarks, it would appear that subsidence did not have the same effect on river waters as on upland waters. He should like to have Dr. Frankland's opinion as to the relative advantages or otherwise of open and covered reservoirs.

Mr. H. ASHTON HILL (Birmingham) did not wish to say anything on the paper; but, having approached Dr. Frankland, and asked him to give the Association a paper, he would like to remark that he was sure the feeling of all present was that they were very much indebted to him for having conferred this favour upon them.

Mr. W. G. PEIRCE (Richmond) inquired whether the softening of water by Clarke's process had not a beneficial effect in the way of destroying the microbes in water.

Mr. F. J. BANCROFT (Hull) thought the paper would be of considerable use to water engineers in enabling them to show that the mere statement as to the number of bacteria in a water was, *per se*, really of no practical value. It had been shown that in the air we breathe and in the soil there were great numbers of microbes; so that mere numbers in the water was only one branch of the subject. The question arose, what, then, was the real value of bacterial examinations. It appeared from what they had heard that the special value they, as water engineers, derived from such an examination was that it was a quantitative estimate of the efficiency of filtration, either natural or artificial; and they had been shown that, by advanced filtration, they could eliminate 99 per cent. of the bacteria in water. He was pleased Dr. Frankland had drawn attention to the way samples of water should be taken for examination, for a neighbour of his (Mr. Bancroft's) had been put to considerable trouble, owing to the imperfect manner in which samples had been collected.

Mr. PRICE (Worcester), alluding to the point as to the effect of subsidence on bacteria, said he had discussed the matter with two engineers who were responsible for river supplies, but who unfortunately had not storage reservoirs. His friends had studied the matter, and had come to the conclusion that they might perhaps obtain the same effect by giving the water a rough first filtration, and then passing it through a fine filter. He should like to know Dr. Frankland's opinion as to the effect of a rough preliminary filtration in comparison with storage.

Mr. W. WATTS (Sheffield) said he came from a district where filtration was not introduced, for the simple reason that they kept the gathering-ground feeding the reservoirs free from all sources of contamination by purchasing the farms, by draining the swampy places, by pitching the channels which fed the water so as to prevent the floods acting upon the sides, and by constructing water-courses to control the floods, and cause them to pass by when there was an excess of rainfall and great turbidity. He held the opinion that all large corporations who acquired their drainage areas should be compelled to purchase the farms existing upon them, so as to secure pure water. He was convinced that the ratepayers of large cities and towns were quite willing to pay a slightly higher sum for the water supply in order to have it pure.

Mr. HAMLET ROBERTS (Ipswich) suggested that analysts who supplied bottles for the taking of samples of water should have the stoppers so made that they could be easily removed and replaced while the bottle was in the water. He referred to the difficulty he had experienced in taking a sample of water from a reservoir in this way for examination by Professor Attfield.

Mr. J. H. SHAW (Boston, Lincs.) gave an illustration from his own experience to show that a bacteriological examination would sometimes detect changes in the condition of a supply which chemical analysis would not.

Dr. FRANKLAND, in reply, said Dr. Kemna had emphasized the importance of constancy in the rate of filtration. In visiting water-works, he (Dr. Frankland) had frequently conversed with engineers on this subject; and he felt confident they did not attribute that importance to preserving a constant rate of filtration which these bacteriological investigations showed were necessary for obtaining the most efficient result. The running to waste of water for a day or two after a new filter was started was not practised to anything like the extent to which it should be in this country. With reference to Mr. Angell's remarks, he (Dr. Frankland) had no hesitation in repeating what he had frequently said on previous occasions, that the mere knowledge of the number of bacteria in water was of no importance whatever. Holding up a glass of water, he said he had not the slightest interest in knowing the number of bacteria per cubic centimetre in that water. What was the history of the water? It had been supplied by the Southampton Corporation; and it had possibly been stored in a cistern. That and other circumstances would influence the number of bacteria without necessarily influencing the quality of the water. But the number of bacteria in a water as it came from a well was a matter of very great importance. They submitted water to processes of filtration, and relied upon those processes to remove bacteria; so that it was not right to say the counting of the bacteria was of no value. That was the only part of the bacteriological examination of water that had any value; and it was required to show what had taken place in the filtration of the water. If they bacteriologically examined the water prior to any purification process and immediately after, it threw more light upon the purification value of that filtration than any other examination to which they could subject the water. Then Mr. Angell threw some doubt upon the numerical results which would be obtained in the event of the presence of suspended or flocculent matter. That would not make any difference at all, because the water would be shaken up, and the particles would be evenly distributed through the water. Supposing such a flocculent particle got into the gelatine tube, there might be hundreds of bacteria on the particle, but it would only give rise to one colony, and not to a large number. Therefore the presence or absence of

such particles would not produce discrepancies as Mr. Angell and other critics supposed. As to Mr. Priestley's question regarding reservoirs, he (Dr. Frankland) did not know enough about the particular water he was referring to to offer any opinion on the subject. Respecting Mr. Peirce's question, an unsoftened water which he experimented with some years ago contained 322 bacteria per cubic centimetre; but after softening by Clark's process, it only contained 4 per cent. It was known that the softening process was particularly efficient in removing bacteria from water. Double filtration, especially if the first was a rough one, was a poor substitute for storage; and it did not give the benefit of being able to select the water for delivery. With reference to Mr. Watts' remarks, he was afraid there were many watersheds of such a character that it was indispensable a process of filtration should be carried out.

At the close of the discussion, Dr. Frankland was accorded a hearty vote of thanks.

CORRESPONDENCE.

[*We are not responsible for the opinions expressed by correspondents.*]

The Accident Fund of the South Metropolitan Gas Company.

Sir,—My purpose in drawing attention, in my letter of the 9th inst., to one or two points in Mr. Livesey's report on the above fund which I thought deserved consideration by those interested in estimating the additional liability entailed upon the gas industry by the Compensation Act of last year, or concerning which further information from Mr. Livesey was to be desired, was quite curiously the reverse of that with which he has credited me, and upon which he has commented with asperity.

He refers somewhat contemptuously to me as "your anonymous correspondent." Being only of the rank and file, I did not wish (and do not intend) to lay myself open to the charge of seeking self-advertisement by publishing over my signature criticism—whether justifiable or not—of a statement put forward by so eminent an authority as Mr. Livesey. It is always a matter of opinion whether the value of a criticism lies most in its intrinsic merits or in the reputation of the critic.

It was the last paragraph in his report, in which Mr. Livesey—after drawing a comparison between the cost of his scheme and his estimate of the cost of the Act—hinted that, unless the number of accidents ceases to increase, "the mutual scheme will have to be dropped, and the Company will then fall back on the Act," that led me to advance some reasons for thinking it possible that Mr. Livesey had over-estimated the amount which he called the "surplus from the Company's contribution."

The very fact that I believe with him that, for many reasons—absence of friction with the men, and economy of costs, more especially—"a mutual fund is the best of all systems," made me apprehensive lest the rather faint praise which Mr. Livesey bestows upon his scheme after its first trial should have the effect of deterring other employers from following his lead.

Does Mr. Livesey really think that if I had been indirectly advocating insurance at the absurdly high, or indeed at any, rates quoted by the offices, I should have particularly pointed out "the total saving of legal or arbitration costs gained by the adoption of a satisfactory mutual scheme for compensation"?

Having, I hope, made my motive more clear than, apparently, it was in my former letter, I must express my surprise that Mr. Livesey should, after concluding to notice an anonymous correspondent, have condescended to misrepresent him.

Mr. Livesey says that I quoted "contributory negligence" as an expression used by him. I quoted the term, not as from Mr. Livesey, his rules, or his report, but in the manner in which it is customary to quote phrases commonly understood to refer to some line of defence at law, as, indeed, the phrase in question was quoted in your "Editorial Notes" of the 7th inst. If Mr. Livesey had carefully read my letter, he would have seen that I referred to his interpretation of the provision of the Act, not to his interpretation of "contributory negligence."

In the suggestion that "gross negligence" was not necessarily a sufficient defence, and might be appreciably different from "serious and wilful misconduct," I relied upon and quoted legal opinion, not merely my own. The "description of 'wilful'" is not, as Mr. Livesey implies, mine, but is the wording of the Act.

The two cases instanced by Mr. Livesey appear to me to come under the category of "wilful misconduct" rather than of negligence simply; for the men not only neglected to do the right thing, but wilfully did the wrong. And it was the act in each case, rather than the negligence, which led to the injury. If the other four cases were of a similar nature, Mr. Livesey is certainly justified in claiming that he would have obtained exemption under the Act, without probably having to contest an action. As to the other sixteen cases in Class A, I should have seen that there was no question but that they were exempt.

But I still maintain that accidents may and do arise from "gross negligence" which could not possibly be deemed the result of "wilful misconduct." A man may, by "gross negligence," be the sole cause of a boiler explosion, with serious or fatal consequence to himself; but would it not be impossible, without importing the theory of suicide, to plead that he was guilty of "wilful"—*i.e.*, intentional—misconduct? A man can scarcely be wilfully forgetful or stupid.

Mr. Livesey's interpretation of "gross negligence" is, however, in one respect even harsher to the employer than the provisions of the Act. He understands it to mean the *sole* negligence of the injured. The House of Lords struck out the word "solely" from before "attributable" in the subsection in point; and the Commons accepted the amendment.

If Mr. Livesey cannot see the importance of ascertaining how many men will, if a scheme be substituted for the Act, make claims upon the Accident Fund, because they feel that they (being subscribers) have a right to do so, who, if no fund were in existence, would not find themselves incapacitated from work, I must leave that question as it stands.

In answer to Mr. Livesey's accusation of selecting figures to suit my own nefarious purposes, I have to say that I took the period of the six years 1892-97 as a basis for calculating the probable average annual cost to his Company of fatal accidents under the Act, because that was the period for which the actual figures and particulars as to dependents were given, and chiefly because Mr. Livesey had apparently based his Company's contribution to their fund on the cost of the accidents—fatal or otherwise—for that period (less the year 1897, when there were no fatal accidents) without correcting for an excessive number of deaths, as I should have thought he would have done if he had considered those years exceptionally unfortunate. If he will correct his grant to the fund to the average of fourteen years, he will then be entitled to estimate his death-rate on a similar basis.

Does not Mr. Livesey's objection to my taking the average for six years rather weaken the arguments by which he contended in his report that any six months' statistics, where 4000 men are concerned, are reliable? Following his line of argument my average, 0·83, must be almost impregnable; being based on experience equal to 216 years' working with 100 men, or, indeed, 2160 years with 10 men. Yet in his own report, he shows that the number of accidents occurring among 3600 men over a period of five years varied as much as from a minimum of 80 to a maximum of 137 per annum. Surely no averages are really valuable, even for a large body of men, other than those calculated on the experience of some considerable period.

If I had not thought that Mr. Livesey had been unfair both to my motives and my contentions, I should not have again trespassed upon your space, as the last paragraph in his letter is as optimistic as to the merits of a mutual scheme as his report was pessimistic as to the first results of his own.

June 23, 1898. G.

The Position and Prospects of Incandescent Gas Lighting.

Sir,—In your issue of the 14th inst. you gave a translation of an article in the "Journal für Gasbeleuchtung" commenting on the atmospheric gas-burners patented by Albert Bandsept and Ottman Kern. The gist of the article is that Bandsept anticipated Kern by patenting the application of the injector principle to the old bunsen gas-burner, in connection with particular modifications of the bunsen tube to effect the drawing in of air and commingling the same with gas in the proper proportions to secure perfect combustion, and thereby obtain the highest possible light emission from an incandescing gas-mantle. The argument of the writer of the article is that the construction of Kern is practically the same as that of Bandsept; but that, as the latter disclosed his construction first, he anticipated Kern.

The sole importance of the subject to the English public is the fact that Kern's patent has been purchased by the Welsbach Incandescent Gas-Light Company, while Bandsept's patent has been acquired by a strong Company who are about to place it upon the market in connection with an improved mantle. The monopoly of the Welsbach Company under the Auer von Welsbach master patent expires on Dec. 12, 1898, and naturally the Company desire the public to believe they have a new and wonderful invention which will give the undertaking a renewed lease of life. The Bandsept burner is the property of an organization backed by powerful financial magnates; and their entering the incandescent gas-light field means serious competition for the Welsbach Company.

The real point of interest, however, for consumers of gas, for gas-supply companies, and for investors generally is this: Have either of the rivals a patent upon which a monopoly can be founded? Bandsept's first patent, No. 17,927, was applied for on Sept. 25, 1895; and Kern's application, No. 294, was made on Jan. 5, 1897. Therefore, Bandsept anticipated Kern by nearly eighteen months. Bandsept's improvements consist in the application of the injector principle—*i.e.*, the employment of a jet of gas, under a pressure higher than that of the atmosphere—to induce the drawing in of a current of air; and of two or more wire gauzes at and near the burner top to atomize the mingled gas and air; thereby securing better commingling of the two. Kern also employs the injector principle to induce the drawing in of the air; but he has a particular construction of the bunsen tube, two truncated cones joined at their small ends, the lower one called a "mixing cone" and the upper "a suction cone." Above these he has an arrangement designed to "atomize" the gas and air mixture. Bandsept's arrangement of injector and of mixing and suction divisions do not materially differ from that of Kern, except that the latter lays stress upon the proportioning of his truncated cones, claiming that when his proportions are observed better results are secured. It is certain, however, that with the Bandsept burner quite as good results are obtained as with the Kern burner.

But Rudolf Langhans, of Berlin, anticipated both Bandsept and Kern. His patent (No. 11,625, of June 14, 1895) describes and claims a construction for the application of the injector principle, with mixing and suction cones practically identical with the arrangements described and claimed by Bandsept and Kern.

The use of an injector—*i.e.*, of a jet of one fluid under higher pressure to induce the flowing in of another fluid subject to a lower pressure—is, of course, old. The employment of an "atomizer" in bunsen burners is also old. It may be possible to effect a combination of two old principles in such a way as to produce a new and better technical effect; but has Bandsept, Kern, or Langhans succeeded in accomplishing this?

As above stated, the main features of construction in the Langhans burner are almost precisely those employed by Kern, except that the burner top, or tip, of the Langhans burner gives a hollow cone flame instead of the solid one given by the burners of Bandsept and Kern. The latter contends that his cone flame has what he calls a hyper-incandescent zone, and by placing therein the mantle to be incandesced, a much higher incandescence, and consequent greater light-emission, is obtained. But everyone who has experimented with bunsen burners knows that there is, with every description of such burners, a flame zone where combustion of the carbon molecules of the gas is more perfect, with consequently a higher temperature. The common old-time expression to denote this well-known fact is "the heat zone of the bunsen flame." The difficulty with the Welsbach mantle is to keep it in this heat zone. So long as the whole mantle remains exactly in the heat zone, one sees a cone of dazzling light; but the oxide skeleton skrinks and parts if it gets out of the zone, and the light-emission drops—the candle power decreases.

If the skeleton does not break within 50 hours, there is a perceptible falling off in candle power until at the end of 300 hours there is a loss of fully 50 per cent. in light. This is due to the shrinkage of the mantle, which withdraws a major part of it from the heat zone of the flame.

The common defect of all gas-mantles made by the impregnation process is shrinking in the bunsen flame; and the fiercer and hotter the heat zone, the more rapid and greater will be the shrinkage. This defect, combined with the inherent fragility of a skeleton of oxides, and the frequent breakages which occur, causes constant annoyance to consumers. Incandescent gas lighting will not be universally employed until someone produces a mantle which will remain in the heat zone of the flame and maintain its candle power, and which will not be destroyed by strong currents of air or wrecked by jars and ceaseless lighting. Mantles possessing these superior qualities will unquestionably be produced, notwithstanding the assertions of certain parties that it is an impossibility.

TECHNOLOGIST.

June 21, 1898.

Income-Tax Assessment.

SIR,—Probably one of the harassing things the gas manager has to deal with outside his general routine is the Income-Tax Assessor. He thinks a gas company capital prey, and does his best to annoy. Will any of your readers kindly reply to the following questions:—

1.—Can they assess on the gross profits as shown on the balance-sheet, or upon the amount actually paid in dividends?
2.—The assessor in my instance claims to be paid on the amount allowed for depreciation (say) 5d. per 1000 cubic feet. Is he right?
3.—Is there any fixed rule laid down by law for Income-Tax Assessors in the assessment of income on gas-works, or is each Assessor allowed to act as he thinks fit?

I hope some of your readers well up in these matters will kindly reply. It may be a benefit to more than one, and open up some interesting correspondence on this vital question.

DARE LUCEM.

June 24, 1898.

An Object-Lesson in Municipal Gas Supply.

SIR,—The Mayor and Council of Philadelphia have decided to lease their gas-works to a private Company, after ten years of complete municipal ownership and operation. That the third largest city in the United States should take this step will excite interest in England, where, as yet, there is no disposition to relinquish the municipal supply of gas to private companies, but rather a tendency in the other direction—*i.e.*, to transfer gas management from companies to municipalities.

During the ten years (1887-97) of municipal ownership in Philadelphia, the rate of wages was fixed above the market rate. The Director of Public Works published a statement that, instead of paying the 1700 labourers $1·75 per day, he could obtain equally competent men for $1·25. This excess of 50c. per day involved an additional annual outlay of nearly $275,000. The relation of wages and salaries to total expenses was 41·8 per cent. for 1896, whereas in Glasgow for the same year it was 25·4 per cent., in Manchester 21·3, and in Birmingham 19·6. (I take these figures from an essay by Dr. Rowe, of the Pennsylvania University.) It is evidently unfair to the general public for the employees of a Municipality to be paid more than the market rate of wages. Then during recent years the City of Philadelphia has been paying $3·11 and $3·14 per ton of coal, when it could have been had for $2·95. In this one item alone, the department could have saved annually from $75,000 to $100,000.

The lease to the Company which is "taking over" the municipal plant is for thirty years; but it contains clauses which provide for re-transfer on certain conditions. If the price of gas is successively reduced from $1 to 85c., 80c., and 75c. per 1000 cubic feet, the City is to receive nothing from the Company except free light for the public lamps, and the plant at the expiration of the lease. The Philadelphians seem to have learnt that the most effective way of eliminating corruption is to reduce to a minimum the functions of their Municipality.

R. N. M'DOUGALL.

Liberty and Property Defence League.
7, *Victoria Street, S.W., June* 21, 1898.

Fylde Water-Works Purchase Scheme.—Last Thursday, the first of the Local Government Board inquiries into the proposed acquisition by the combined Councils of Blackpool, Fleetwood, Lytham, and St. Annes of the Fylde Water-Works was held at Blackpool by Colonel Luard. It was stated that the area of supply extended to 120,000 acres; while the population had increased from 39,975 in 1861, to 94,469 in 1897. The Inspector, in closing the proceedings, remarked that there seemed to be a general feeling in favour of the purchase.

Wolverhampton Public Lighting.—At the last meeting of the Wolverhampton Town Council, Alderman Mander moved a recommendation of the Lighting Committee, to the effect that the contract with the Gas Company, for a supply of gas to the public lamps, buildings, &c., of the borough be renewed for a further term of one year, from the 1st of July next, upon the same terms as the existing contract, except that the Committee be empowered to arrange for the conversion of all existing "season" lamps into annual lamps. The Alderman said there were always complaints in the summer season about the lamps being turned out at night. There were 1420 lamps in the borough, and of these 834 were season lamps, and were turned out from May 10 to Aug. 1. Thus two-thirds of the lights of the borough were extinguished at what was often the darkest portion of the year. He suggested to the Company that they might light these lamps all the year round, and charge about £200 a year for it; but the Company would not agree to this. He asked the Council, therefore, to grant the Committee a free hand to spend £400, if needful, in converting the season lamps into annual lamps. Mr. Levi Johnson seconded the motion; saying he thought for the small economy it was not worth leaving part of the town in darkness. Mr. Greensill invited the Council to accompany him round the Park between 11 p.m. and 2.30 a.m., which was just the time when burglaries and other evils were committed; and one lamp was worth two policemen as a preventive. The proposition was unanimously carried.

PARLIAMENTARY INTELLIGENCE.

HOUSE OF LORDS.

The following further progress has been made with Bills:—

Bills brought from the Commons, read the first time, and referred to the Examiners: Higham and Hundred of Hoo Water Bill, Local Government Provisional Orders (Gas) Bill, Maldon Water Bill, Middlesbrough Corporation (Gas) Bill, Mid-Kent Water Bill, Wey Valley Water Bill.

Bills read a second time and committed: Gainsborough Gas Bill, Gaslight and Coke Company Bill, Matlock Urban District Council Bill, Rhymney and Aber Valleys Gas and Water Bill.

Bills reported, with amendments: Carmarthen Improvement Bill, East Ham Improvement Bill, Forres Water Bill, Heywood Corporation Water Bill, Newcastle and Gateshead Water Bill, Northam Urban District Water Bill, North Warwickshire Water Bill, Rochdale Corporation Water Bill, Southend Water Bill, Staines Reservoirs Committee Bill, Todmorden Corporation Water Bill.

Opposition withdrawn: Cranbrook District Water Bill, East Ham Improvement Bill, Forres Water Bill, Southwark and Vauxhall Water Bill, Staines Reservoirs Joint Committee Bill, Water Orders Confirmation Bill.

Bills read the third time and passed: Carmarthen Improvement Bill, Gloucester Gas Bill, Ilford Improvement Bill, Thanet Gas Bill, Todmorden Corporation Water Bill.

Petitions have been presented against The Gaslight and Coke Company Bill from the London County Council and the Corporation of London; and against the Matlock Urban District Council Bill from the Matlock Bath Urban District Council.

The Cranbrook District Water Bill, the Southampton Gas Bill, and the Wigan Corporation Bill have been referred to a Select Committee, consisting of the Earl of Egerton, the Earl of Mayo, Lord Castlemain, Lord Manners, and Lord Monckton; to meet on Tuesday, June 28.

HOUSE OF COMMONS.

Thursday, June 23.

THE PROTECTION OF SOURCES OF WATER SUPPLY.

On the order for the consideration of the Higham and Hundred of Hoo Water Bill,

Mr. CHAPLIN, in accordance with notice, moved a number of clauses applicable to this and other Water Bills.

Mr. CAREW, on a point of order, asked whether it was permissible for the right hon. gentleman to move the addition of these clauses to a Private Bill, seeing that they were amendments of the general law, and would override the decision of the Select Committee.

Mr. CHAPLIN submitted that the clauses would not have the effect stated by the hon. member, and mentioned that the course he was following had been adopted after consultation with the Chairmen of Committees of both Houses of Parliament.

The SPEAKER said he did not see anything irregular in the clauses or in the course adopted by the right hon. gentleman.

Mr. CHAPLIN then proceeded to move the clauses, which were given in the "JOURNAL" on the 31st ult. (p. 1271). He said it was impossible, owing to pressure of business, to introduce the clauses in a Public Bill, and with 21 Water Bills before the House, and in view of the disasters at Maidstone, King's Lynn, and Camborne, he was anxious to make some effort to improve the position; and the present opportunity offered itself. This was a question directly affecting the public health; and the need of reform could not be denied. There was nothing in the clauses to which reasonable objection could be taken; and he hoped the House would support him in the matter, having regard to the useful and beneficial proposals the clauses contained.

Mr. MELLOR urged the right hon. gentleman to withdraw the clauses, and deal with the whole question by means of a Public Bill.

This course having been supported by Sir J. PEASE, Sir W. HART DYKE, and Mr. J. W. LOWTHER (the Chairman of Committees),

Mr. CHAPLIN said he was certainly not prepared for the reception—the mistaken reception, as he thought—which the House had given to his proposals. Owing to the number of complaints he had received, he was anxious to deal with the matter, even to a partial extent, during this session. At the same time he recognized that the general sense of the House was against proceeding with the matter further in its present form; and, in the circumstances, he would best fulfil his duty by asking the permission of the House to withdraw the clauses.

This statement was received with cheers; and the clauses were, by leave, withdrawn.*

The following further progress has been made with Bills:—

Bills read a second time and committed: Felixstowe and Walton Water Bill, Filey Water and Gas Bill, Newhaven and Seaford Water Bill, Newtown Water Bill, Wath-upon-Dearne Urban District Council Bill.

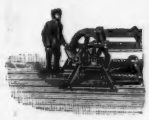
Bills reported, with amendments: Blackpool Improvement Bill, Hamilton Water Bill, Kettering Water Bill, Sheringham Gas and Water Bill, Stirling Gas Bill.

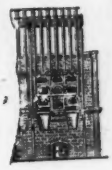
Bills read the third time and passed: Higham and Hundred of Hoo Water Bill, Maldon Water Bill, Middlesbrough Corporation (Gas) Bill, Mid-Kent Water Bill, Wey Valley Water Bill.

Petitions have been presented against the Carlisle Corporation Water Bill, from the Brompton Rural District Council and the Earl of Carlisle; against the Filey Water and Gas Bill, from the Filey Water and Gas Company; and against the Newhaven and Seaford Water Bill, from the Newhaven Urban District Council and the Seaford Urban District Council.

Just before the House adjourned last Tuesday, an order was made, on the motion of Mr. Cohen, for the appointment of a Select Committee to "inquire into the powers of charge conferred by Parliament on the Metropolitan Gas Companies, and to report as to the method in which those powers have been exercised, having regard to the differences of price charged by the various Companies."

* This matter is further dealt with in our "Miscellaneous News" columns.





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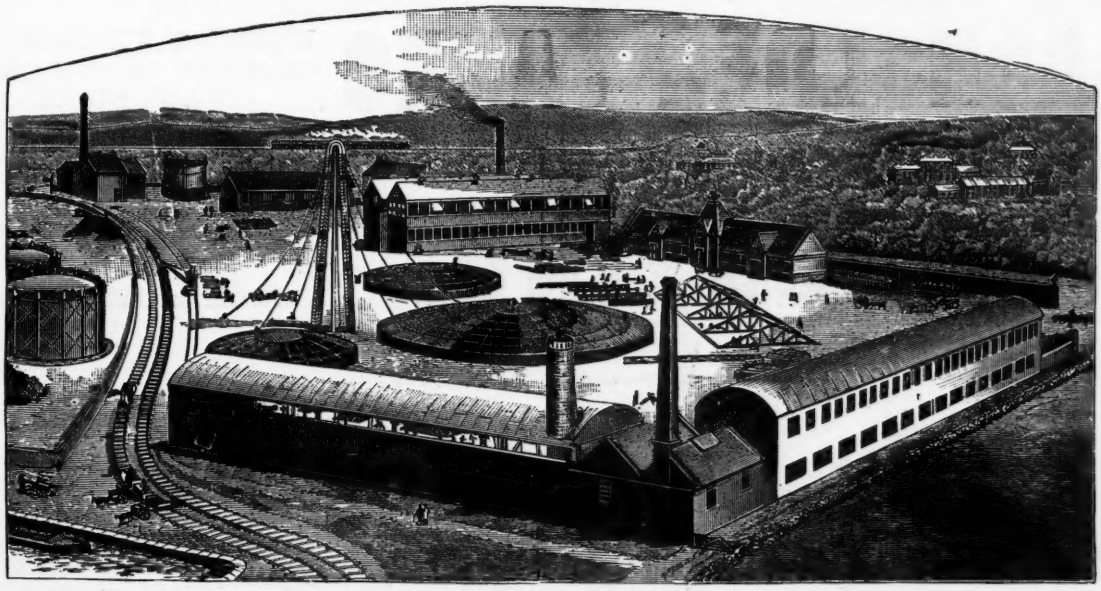

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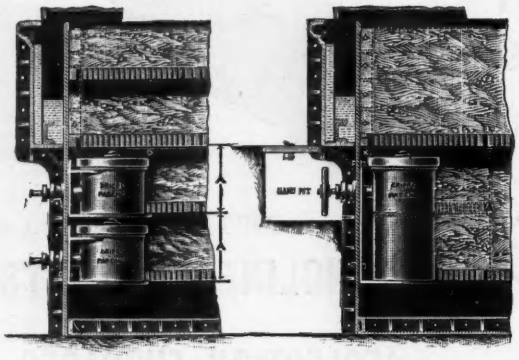
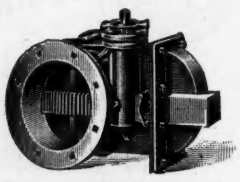
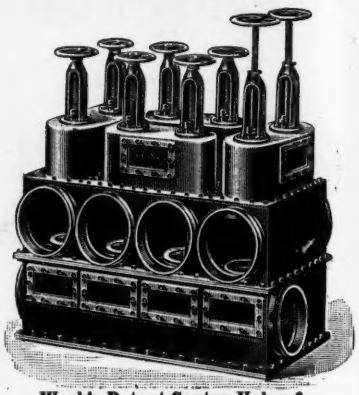


Cripps' Patent Grid Valves for Bye-Passing any Tier in a Purifier.



Internal Rack and Pinion Valve.

1898 PATTERN.



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LEGAL INTELLIGENCE.

HIGH COURT OF JUSTICE—CHANCERY DIVISION.

Tuesday, June 7.

(*Before Mr. Justice* STIRLING.)

Grand Junction Water Company v. Hampton Urban District Council.

This was an action brought for the purpose of obtaining a declaration that the plaintiffs were entitled to erect the necessary buildings for their water-works on lands they had taken under the compulsory powers conferred upon them by their Act of Parliament.

Mr. BOSANQUET, Q.C., Mr. MACMORRAN, Q.C., and Mr. C. GLEN appeared for the plaintiffs; Mr. JENKINS, Q.C., and Mr. COURTHOPE MUNROE for the defendants.

Mr. BOSANQUET said the action was set down for argument on points of law, which were substantially two—viz., first, that his Lordship had no jurisdiction to make the declaration asked for; secondly, that the plaintiffs were not entitled to it on the merits of the case. The question arose in this way: The Company had abutting on two roads within the district of the Council, certain land on which they proposed to erect an engine-house for the purpose of their works. The Council objected to their doing so, on the ground that the proposed building would project beyond the line of the adjoining buildings, and would therefore be in contravention of the Public Health Act, 1888. On the 11th of November last, notice was given that if "the building was proceeded with, legal proceedings would be taken to prevent it." The plaintiffs subsequently gave notice that they intended to proceed; and on the 7th of March, a further notice from the defendants having been received, the writ was issued, with the object of getting the rights of the parties determined. He understood that it would be contended on the other side that the Court had no jurisdiction to make any such order as was asked; but that the question must be decided by the Magistrates, under section 3 of the Act of 1888. He should submit, on the authority of *Lord Auckland v. Westminster Local Board of Works* (L.R. 7, Ch. App. 597), that there was jurisdiction; and he pointed out at length the inconvenience which would arise if it were held that such important questions could only be settled by criminal proceedings before Magistrates, with an appeal to the Divisional Court simply on points of law.

Mr. JENKINS said a summons had already been taken out, and the plaintiffs had been convicted by the Magistrates. They applied for a special case, but had not proceeded with it. He should ask leave to amend the defence by stating these facts.

Mr. BOSANQUET said the special case had not been proceeded with, pending the present action.

At the conclusion of the argument on the preliminary question as to the jurisdiction of the Court to make the declaration asked, his Lordship reserved judgment.

Tuesday, June 14.

Justice STIRLING to-day proceeded to deliver judgment. He said the question was whether he ought to allow an action to go on which simply asked for a declaration that the plaintiffs were entitled to erect an engine-house. Having regard to the decisions in *Lord Auckland v. Westminster Local Board of Works*, *Carr v. Corporation of Preston*, and *Stannard v. Vestry of St. Giles, Camberwell*, it could not be said there was not jurisdiction in the Court to restrain proceedings before a Magistrate. There was no ground for interference by the Court upon the footing that the defendants threatened or intended to do an illegal Act. All they threatened to do was to proceed before the Magistrates in the way pointed out by section 3. To grant an injunction in such a case was to do something which ought to be done with the greatest possible caution; and, adopting the language of the late Sir George Jessel, "where the Legislature has pointed out a mode of proceeding before the Magistrates, it is not right, as a general rule, for another Court to stop that proceeding by an injunction." In a contest between local authorities and private owners, the rule ought to be adhered to somewhat strictly. The Legislature had provided a cheap and short mode of obtaining a decision on any point as to a building line; and it would be a matter of regret if a different and more expensive mode of obtaining a decision were to be resorted to in the absence of very special circumstances. His experience led him to believe that vestries and other local authorities were sometimes too ready to embark in costly litigation without any equivalent benefit to the ratepayers whom they represented; and he should be sorry if private individuals or a vestry, where a cheap and speedy mode of settling a dispute was provided by the Legislature, could resort to a more expensive remedy. The Court ought to be slow to grant an injunction against taking proceedings before the Magistrates when the Legislature had pointed this out as the proper mode of proceeding; and, *a fortiori*, when the Court was simply asked to make a declaration of right without giving any consequential relief, it ought to be extremely cautious in making such a declaration, and ought not to do so in the absence of very special circumstances. Were there special circumstances in this case? He thought not.

As the disposal of the point of law really put an end to the action, his Lordship ordered it to be dismissed with costs.

HIGH COURT OF JUSTICE—QUEEN'S BENCH DIVISION.

Tuesday, June 14.

(*Before Mr. Justice* MATHEW.)

Elliott v. Ludlow Union Gas Company.

This was an action by a former Manager of the defendant Company to recover £27 15s., being dividends on shares held by him in the undertaking. The Company admitted the claim, but, by way of counterclaim, sought to recover a much larger amount; and the onus being upon them, they had to open. Mr. Elliott, who for many years was the Manager of the Company, was the inventor of an improvement in retorts; and the Company (according to their case) permitted him to erect upon their premises some retorts for the purpose of making experiments with the invention, and subsequently displaying it to persons who were negotiating for its purchase. The retorts were put up in 1888; and the Company, besides paying for their erection, as well as for certain repairs, purchased them for £60 when Mr. Elliott left. Some of this amount they contended ought to have been paid by Mr. Elliott. Another part of the counterclaim was in respect of money which it was alleged the plaintiff had received on behalf of the Company from persons using a weighing-machine belonging to them. Plaintiff contended that he had faithfully accounted for every penny received, and said that, as the Company had had the use of the retorts, he ought not to be called upon to pay for repairs or the expense of fitting up.

Mr. CRAWFORD and Mr. HODGES appeared for the plaintiff; Mr. A. T. LAWRENCE, Q.C., and Mr. SPEARMAN represented the Company.

Justice MATHEW, in giving judgment, said the claim of the defendants was based on the fraud of the plaintiff; and this charge had been persisted in to the last, notwithstanding the position of trust which Mr. Elliott had occupied. The plaintiff was an inventor, who, with the assistance of the Company, had put up three retorts, which had been used by the Company for many years in the manufacture of gas. From time to time, in perfecting the invention, plaintiff spent money upon it. What he did was done openly; and there was no fraud in the matter at all. The accounts were sent in to the Secretary and were paid. He (his Lordship) was satisfied there was no foundation for the charge of fraud. As to the next item—viz., the sums received for weighing—he thought this was one of the most contemptible cases that had ever come before a Court. It appeared that in 1880 the amount received for weighings was about 14s. or 15s. a year; and yet a man who had served the Company for many years, to their great credit and advantage, was now charged with embezzling the sum of 3d. or 4d. per week. The certificate which plaintiff had from the Chairman of the Company showed that he was a very valuable servant. There was nothing upon which plaintiff could be convicted of dishonesty in the matter. He believed that every penny received had found its way into the coffers of the Company. There would be judgment for the plaintiff for the amount claimed, with costs on the High Court scale; and also judgment for him on the counterclaim.

HIGH COURT OF JUSTICE—QUEEN'S BENCH DIVISION.

Saturday, June 25.

(*Before Mr. Justice* WILLS *and a Special Jury.*)

Hughes and Lancaster v. The Erith Urban District Council.

This was an action in which the plaintiffs' claim was for damages to air-mains laid by them in the defendants' district under contract with them, and for the cost of restoring and making good such mains.

It appeared from Counsel's opening statement that the plaintiffs, Messrs. Hughes and Lancaster, of Victoria Street, Westminster, are the licencees of the Shone ejector sewerage system, with which they have had great experience. The defendants are the Local Authority for the Urban District of Erith, and as such are empowered by the Public Health Act, 1875, to construct sewers for the district. In pursuance of these powers, they entered into a contract with Messrs. Ossington for making certain sewers, and also into one with the plaintiffs for the construction of certain ejectors and air-mains in connection with the proposed new sewerage system. The air-mains were to be laid underneath the roads, but above the sewers. The plaintiffs constructed a considerable portion of the air-mains. The plaintiffs alleged that the defendants, by Messrs. Ossington and Sons, their contractors, improperly and negligently performed the work of constructing the sewers, with the result that subsidence was caused, by reason of which the air-mains were "let down, disjointed, and injured." The plaintiffs were put to great expense in taking up, relaying, and repairing the mains, and making good leakages; and under these circumstances, they claimed £250 damages.

The defence was that the contract referred to was made with Mr. George Ossington, and not with Messrs. Ossington; and the defendants did not admit that the air-mains were to be laid above the sewers. It was denied that they, by Messrs. Ossington and Sons or otherwise, improperly, imperfectly, or negligently performed the work of constructing the sewers. They said that if the mains were injured it was not due to the way in which the work was done by the defendants. It was also said that the mains had never been accepted by the defendants, and that by the terms of the contract the plaintiffs were liable for their repair. Without admitting that the plaintiffs had suffered damage or expense, the defendants said that if there was such it was due to the improper position and negligent manner in which the plaintiffs had laid the mains.

Evidence was called of a technical character, the hearing of which extended over two or three days.

In the result, the Jury found (1) that the plaintiffs' work was properly done; (2) that the leakage discovered in April, 1897, was caused by the lateral subsidence of the soil; and (3) that this subsidence was due to negligent work by Ossington in filling up the trenches.

After considerable argument as to how judgment should be entered on these findings, his Lordship said he would take time to consider the question, as the case was by no means free from difficulty.

SHOREDITCH COUNTY COURT.—Friday, June 17.

(*Before Mr.* PITT-LEWIS, Q.C., *Deputy-Judge.*)

Claim for Damages Caused by an Explosion.

To-day Mrs. Emmeline James, of 76, Stoke Newington Road, N., eating-house keeper, sought to recover from The Gaslight and Coke Company the sum of £50, for damage done to the house, and personal injuries sustained by her daughter, through an explosion of gas on Sunday, the 13th of March.

Mr. LESTER appeared for the plaintiff; Mr. LOENIS represented the Company.

Mr. LESTER, in opening the case, said the circumstances were peculiar. The gas-meter of the Company was in the basement of the premises, above which was a dining-room for the plaintiff's customers, and above

that another dining-room which was only in use on Sundays; and it would be shown that it had not been used for a week previous to the explosion. On March 8, a smell of gas was noticed in the shop, and a messenger was sent to the Company with the idea of having the defect righted. A man called next day, and screwed up two or three taps under the counter. The following day he returned with another man, bringing with him a fresh meter, which they put in the place of the old one. As the latter was being taken away, it was noticed that it had a large hole in it. Three days after this, the plaintiff's two daughters went up to the dining-room in the afternoon. One lighted the gas at the chandelier, and the other struck a match with the idea of lighting the fire. She stooped down to put the flame to the paper, when immediately there was an explosion, and she was thrown to the ground. Mr. Lester pointed out the curious fact that the light in the chandelier was burning after the explosion, which seemed to show that the cause of the accident was not an escape from the chandelier. He submitted that the gas from the defective meter had in some way accumulated in the chimney flue, and that it exploded directly the light was put to it.

Miss *Lottie James* was called, and stated that as the old meter was being taken away one of the men pointed out a hole in it, and remarked that it was not to be wondered at that there had been a smell of gas. She then noticed the hole in the side of the meter. She described how the explosion took place on the Sunday; and said her nerves had been so upset that she had not been able to work since. She did not smell gas as she entered the room. The effect of the explosion was that the whole of the front of the room was blown into the street, and the curtains were set on fire. The Fire Brigade were called, and they said the chandelier was the cause of the explosion, as there was no water in it; but the gas was burning when the firemen arrived.

Miss *Florence James* corroborated generally her sister's statements.

Frank Haynes, a gas-fitter, said he supplied the chandelier with water in January, and it should not have required replenishing for a year. He attributed the explosion to an accumulation of gas in the flue. The gas could not possibly have come from the chandelier, as it was nearly full of water. His idea was it came from the defective meter in the basement.

Plaintiff was then called, and gave particulars of the different amounts she was claiming to make up the £50.

Mr. *W. Wells*, the chief officer at the Stoke Newington Fire Station, said his theory as to the cause of the explosion was a leakage of gas from the chandelier. He came to this conclusion before he pulled the chandelier down; and when he did this he found it quite empty. He had no reason for supposing that the gas came from the meter.

His Honour: If your theory is the correct one, how do you account for the accumulation of gas in the flue, if there was any?

Witness: I do not think for a moment that there was. My knowledge of explosions tells me practically that there was not. The explosion seemed to have occurred at the ceiling; and there was direct evidence to show that the paper on the wall had been blown in a downward direction. This, to my mind, supports the theory.

Charles E. Clowney, a fitter in the service of the Company, stated that when he went to inspect the meter on the 8th of March he was told it was not convenient for him to do so; and he had to put up the taps.

His Honour, in summing up, expressed regret that he had not heard some expert witnesses on the point whether or not gas would be likely to accumulate in the flue, as alleged. This, however, did not particularly concern him. The plaintiff had to prove that there had been an absolute breach of duty on the part of the Gas Company; and this she had certainly failed to do. If the explosion had occurred at the grate, as asserted, it was marvellous that no damage should be done near it, and yet all the windows be blown out. It was quite as likely that the chandelier leaked as that the gas had accumulated from the defective meter, so far as the case had been put before him. Therefore he must say that the plaintiff had failed to make out her case, and that there must be judgment for the defendants.

Mr. Loenis pressed strenuously for costs; and they were eventually allowed.

The Liverpool Corporation and the Water Supply of Prescot.

Last Tuesday, the Liverpool Corporation were again summoned at the Prescot Petty Sessions in respect to the water supply to the Prescot Conservative Club. Two summonses were down for hearing, one having been adjourned from May 17, and the other a new summons entered by Mr. Harry Mercer, the Secretary of the club, in respect of the insufficiency of the water supply in May and June. Mr. Collingwood Hope appeared for the prosecution, and Mr. E. W. Pierce, the Assistant Town Clerk, defended. Mr. Pierce made an application that the proceedings should be adjourned until an appeal from a recent decision of the Court of Quarter Sessions on a similar case had been heard. Mr. Collingwood Hope objected, on the ground that the Corporation had made the appeal unnecessarily. The Magistrates agreed to adjourn the first case, and proceeded with the hearing of the new summons. Evidence was given by Mr. Mercer to the effect that there was rarely during the daytime any direct supply of water from the main to the club premises. They had to depend upon a cistern at the top of the building for their supply during the daytime; and even then they had to use the water very moderately, or else the supply would run short. Mr. Pierce admitted that, if the Corporation were under an obligation to give a supply to the top storey of every building in Prescot, there were two or three instances where they had failed; but they maintained that, in each of these cases, including the one the Bench were now dealing with, they had given a sufficient supply. No man occupying these premises was ever short of water for ordinary purposes. The Corporation gave the club an ordinary and sufficient supply for £2 12s. 6d. a year; but they did not undertake to supply them with water for baths for 400 members. The Corporation had any quantity of water; but it was a question of gravitation. There were three houses in Prescot to which they could not get to the top storey; and the question was whether they were to spend several hundreds of pounds to give the supply, which would be of very doubtful benefit. The Bench decided to convict, and inflicted a penalty of £2 and 1s. a day from May 11 to June 15. On the application of Mr. Collingwood Hope, they granted costs against the Corporation to the extent of £10. Mr. Pierce said the decision would be appealed against.

MISCELLANEOUS NEWS.

EDINBURGH AND LEITH GAS COMMISSIONERS.

The Annual Accounts.

The accounts of the Edinburgh and Leith Gas Commissioners for the year ending the 15th ult. have been issued, subject to audit. They are accompanied by a summary by Mr. John S. Gibb, the Treasurer. It shows that the surplus on the year's working is £54,994, from which there has been paid: For annuities, £33,503; Edinburgh-Portobello gas annuities, £1200; amount transferred to the sinking fund in respect of annuities redeemed, £497; do. in respect of mortgages redeemed, £139; interest on mortgages, &c., £6768; expenses of mortgages, £252; balance of expenses of transfer of the Portobello gas undertaking, £524—making together a total of £42,884. After meeting these charges, there remains a balance of £12,110, which being added to the amount brought forward, after taking away the contributions to the sinking funds (£24,480), makes the total sum at the credit of the profit and loss account £36,590. This is subject to the statutory minimum charges for the sinking funds as follows: (1) For repayment of money borrowed, £2204; (2) For redemption of annuities, £7311—together, £9515. This amount being deducted from the £36,590, leaves a balance of £27,075, which may be dealt with at the discretion of the Commissioners in terms of their Act. The Treasurer states that "as the work embraced in the first two items in the suspense account is now completed, I recommend that these items should be dealt with by the Commissioners at an early date. The favourable balance, and the reserve fund (originally set apart for similar outlays) give the means of meeting the revenue portion of this expenditure, without encroaching unduly on the working balance."

The capital account shows the stock capital to amount to £363,414, upon which annuities are payable to the amount of £34,560. The loan capital, the total authorized amount of which is £400,000, is £220,398—leaving £175,301 to be borrowed; but the Commissioners have redeemed £4300 of mortgages, to which extent the borrowing powers are cancelled. The total amount now borrowed is stated to be £224,698. During the year the additions to capital amounted to £43,975, of which £22,500 is the value of the Portobello gas undertaking, which was acquired in the period dealt with. Mains and service pipes, and the cost of laying came to £16,785. There was expended upon meters £6564; and upon gas cooking and heating stoves, £3636. The revenue account shows the receipts to amount to £247,047; and the expenditure to £192,052. Of the receipts, the sum of £228,061 was for gas (1,557,256,300 cubic feet); £5613 for coke; £12,966 for tar and ammoniacal liquor; and £28 for waste lime. On the expenditure side, the carbonizing department cost £147,402, of which £83,490 was for coal (155,240 tons); £4262 for oil for carburetted water gas (1373 tons); £7995 for purifying materials; £39,869 for salaries, wages, and charges at works; and £11,786 for repairs and maintenance of works and plant, including alterations to the new chimney at the Edinburgh works. The distribution of gas cost £23,657, of which £10,246 was for salaries and wages; £7819 for repairs and maintenance of pipes and attendance at gasholders; and £5591 for repairs and maintenance of meters. Management cost £8259; feu duties amounted to £329; and rates and taxes to £6569. Statutory pensions amounted to £450; and allowances to old employees unable to work, and to representatives of deceased employees to £1013. Discounts and bad debts came to £4537. The sinking fund for repayment of money borrowed came to £14,660; but there has been expended upon redemption of mortgages, £4300—leaving the fund at £10,360. The sinking fund for the redemption of annuities amounted to £92,711; but there has been expended in redemption of annuities £19,406 (£11,109 during the past year)—leaving the fund at £73,304. The reserve fund amounts to £3184. The profit and loss account shows that under the suspense account there was laid out last year: Upon carburetted water-gas plant in the Edinburgh works, £24,264; upon a new retort-bench at the Leith works, £505; as expenses of the Commissioners Act of 1898, paid to the 15th of May, £1193; and as expenses connected with the new works at Granton, paid to that date, £200. The gas-stove account shows that at the beginning of the financial year there were stoves on hand, or lent on hire, of the value of £4028; that there was expended in the purchase of stoves during the year, £4108; and that the repairing and fitting up of stoves cost £1363—a total charge of £9499. There was received, as hire of stoves, £1267; for stoves sold, £418; and for fitting up stoves, £149—making a total of £1834, and leaving, as the value of stoves, &c., on hand or lent on hire at May 15, £7665. The accounts were laid before the Commissioners at a meeting held yesterday.

PLYMOUTH AND STONEHOUSE GAS COMPANY.

The Annual General Meeting of this Company was held last Thursday—Mr. G. Henderson in the chair.

The report of the Directors stated that there had been a slight reduction in the gas-rental, as well as in the amount received for residual products. This was accounted for by the high temperature which prevailed during the past winter, and the continued depression in the prices of coke, tar, and sulphate of ammonia. The accounts showed that, after payment of the authorized dividend in January last, together with interest on the debenture stock, the balance remaining to the credit of the profit and loss account amounted to £19,312, from which the Directors recommended the payment of a dividend for the half year ending March 31 of 6½ per cent. on the ordinary stock, 9s. 9d. per share on the additional shares, and 9s. 3d. per share on the new shares created by the Act of 1879. This would absorb £6790, and leave £12,521 to be carried to the credit of the next account. Satisfaction was expressed at the fact that at the sale of £10,000 of ordinary stock in March last the average price obtained was £152 3s. 11d. per cent.; and also at the settlement of the litigation with Mr. Ward by an agreement for the purchase of his works. The Directors further reported that, with a view to increasing the consumption of gas among the working classes, they hoped to shortly introduce the automatic prepayment meter system, and also the hiring of gas stoves, engines, &c.

The expenditure on capital account during the year was £18,841; making a total of £245,023. On revenue account the receipts were: Sale of gas, £66,043, as compared with £65,941 in 1897; meter-rents, £3739, against £3657; residuals, £16,280, against £17,327; and rents, £561, against £551. The expenditure on manufacturing account was £62,076, against £62,289 last year; distribution, £4468, against £4415; public lamps, £1258, against £1301; rents, rates, and taxes, £2152, against £2053; and management, £3162, against £3107. The coal account showed that 77,347 tons of coal and 681 tons of cannel had been carbonized, and 353,566 gallons of oil used.

The Chairman, in moving the adoption of the report, said that notwithstanding the mild winter and the depreciation in the value of residuals, which affected them to the extent of £1000, the total receipts amounted to £86,901, and they were able to carry £13,140 to the credit of the profit and loss account; being only £531 less than last year. Taking into account the low price at which the consumers were supplied with gas in Plymouth, it was a source of great satisfaction to the Directors that they were able to congratulate the shareholders on the present position of the affairs of the Company. After payment of the maximum dividend, there remained a sum of £12,521 of undivided profits; and the reserve fund stood at £18,444. The Company had to bring their coals from Newcastle. The Newcastle Gas Company could get coals into their works at the same price that the Plymouth Company had to pay for putting them on board their steamers. The freight, quay dues, cartage, &c., on between 70,000 and 80,000 tons of coal a year amounted to £18,000; so that Plymouth was seriously handicapped as compared with Newcastle. Yet in the latter town the price of gas had recently been put up to 2s. per 1000 cubic feet, whereas Plymouth gas remained at 1s. 9d. The difference between 1s. 9d. and 2s. would amount, on the consumption in Plymouth, to something like £9000 a year. This must be a satisfactory state of things for the Plymouth consumer. During the past year, the number of meters in use had been 12,124—an increase during the year of 344. They had laid on 388 new services, and renewed 332. They had laid, in extensions and renewals, more than 2½ miles of mains. In consequence of the unsettled state of the coal market through the strike in South Wales, the Directors had not entered into any contracts for this year's supply. The question of the electric light had received their attention. In the West-end of London, and also in Dublin, it was found more profitable for consumers to put in their own installations, and use gas-engines for generating electricity, than to take the public supply. If this were so with gas at 3s. per 1000 cubic feet, it would be more so with the price at 1s. 9d. With regard to the Bill which the Company were promoting this session, the Corporation of Plymouth lodged a petition against it; and though at the last moment it was withdrawn, the Company had to spend £1000 in meeting it. In 1894, the Corporation laid out between £8000 and £9000 in opposing the Company, and as the result got only an increase of the illuminating power from 14 to 15 candles, which, as the Company had been supplying 15-candle gas, was really no advantage at all. In their petition against the present Bill, the Corporation said they were large consumers of gas, and representatives of the consumers generally. The fact was, however, that the consumers who were the largest ratepayers, had to pay the extra rates which were the outcome of this policy in municipal affairs.

Mr. J. A. Bellamy, in seconding the motion, said it would be better if the Corporation endeavoured in future to settle these matters by a little friendly interchange of ideas. The Corporation had not to do with a Company who charged an excessive rate for their gas. Whenever they were before a Parliamentary Committee, they were able to point to Plymouth as the premier Gas Company in the country, with the lowest rate for gas; while the way in which the affairs of the Company had been managed had always called forth the highest commendation. Another petition lodged against the Company's most recent Bill was on behalf of various persons residing in the neighbourhood of the gas-works, and owners of property, who had found it to their interest to build working-class dwellings close to the Company's premises. The petition admitted that these houses were always fully tenanted; and this was the best answer to the complaint that the gas-works created an intolerable nuisance. The Directors declined to discuss that opposition in any shape or form; and from the result of the attitude taken up, they were determined in future—first of all, of course, keeping their house in perfect order, and leaving nothing undone that could be done to render the industry innocuous—to challenge any opposition that might be brought forward. With reference to the proposal to supply gas-stoves, he might explain that it had not hitherto been done in Plymouth for various reasons—one of the chief of them being a desire not to interfere with local tradesmen. At last the presence of competition and pressure from the public had compelled them to take a new departure. The Directors had succeeded in making a satisfactory arrangement with a leading firm of stove manufacturers in London. From applications already received, and the results obtained in other towns, he had no doubt there would be a very large demand for such conveniences. The price would be kept down to the lowest possible limit; the aim of the Company being not to make a profit from the stoves, but to increase the output of gas. This arrangement was all in favour of the consumer. Gas-fires would be sold on the four-years purchase system; and arrangements were also in progress by which consumers who desired to have electric light could obtain gas-engines also under that arrangement. Electric light would be produced in this way at 50 per cent. less cost than that at which the Corporation could supply the light, assuming that that body debited each branch of its business in a proper and honest manner. The Company had no reason to fear competition from electricity in Plymouth, with gas at 1s. 9d. per 1000 cubic feet, with the introduction of the incandescent gas-light, and with the determination of the Directors to take advantage of every invention worth using. On the contrary, he was satisfied that they would not only maintain, but greatly increase, their annual output; and that in future years they would have the double advantage of an augmented consumption of gas during the daytime.

The report was adopted; the dividends recommended were declared; and the retiring Directors and Auditor were re-elected.

Mr. T. G. Wills moved a vote of thanks to the Chairman, Deputy-Chairman, and Directors for their services.

Mr. W. Snow seconded the motion; and it was carried.

The Chairman acknowledged the compliment, and alluded to the case in which the Swansea Gas Company obtained an injunction against the Town Council, restraining them from using the borough fund or the rates to meet the expenses of the opposition to the Company's Bill, which they had entered upon without first obtaining the consent of the ratepayers (see *ante*, pp. 655, 723). The case, added Mr. Henderson, should be a salutory lesson to other Town Councils.

On the motion of Captain Julian, seconded by Mr. W. Padfield, the Secretary (Mr. J. Thomas) and the officials were thanked.

Mr. Thomas replied.

The services of the Company's Solicitor (Mr. J. Shelly) were also acknowledged.

At the close of the meeting, the shareholders were conducted round the works by Mr. A. Wharton, the Engineer and Manager. Special attention was given to the water-gas plant installed last year, which is now being duplicated by Messrs. S. Cutler and Sons. The plant will then have a capacity of 3 million cubic feet per day. In the retort-house, which was the subject of so much concern and trouble owing to complaints that it was a nuisance to the neighbourhood, Mr. Wharton pointed out that the latest device for ventilation consists of seven openings on the south side, into which fans draw the smoke and vapour. It then passes into washing chambers, and finally into the open air. The old coal-store is being converted into a workshop for repairing stoves and prepayment meters. On the Company commencing the working of the scheme to which Mr. Bellamy referred, a show-room will be opened in the town; but the work connected with the fitting up of houses and the overhauling of stoves and meters will be carried out at this new workshop. Arrangements have been entered into with Messrs. Richmond and Co., Limited, for the supply of gas stoves and fires, and with Messrs. Willey and Co., of Exeter, for prepayment meters and fittings. Houses in which these meters are put up are to be fitted free of cost with one pendant, two brackets, and a cooker. The fitting will be done by Messrs. Willey and Co., whose workmen will also fit up the hired gas-stoves. Before leaving the works, the shareholders partook of light refreshments; and afterwards the Directors and a few guests had lunch together.

WORKMEN'S COMPENSATION.

Insurance as to Profit-Sharing.

The "Pall Mall Gazette" last Friday contained the following particulars of an important scheme of workmen's compensation, which we reproduce as an interesting contribution to a subject which is now occupying the attention of a great many of our readers:—

With the approach of July, at the beginning of which the Workmen's Compensation Act of 1897 comes into force, the Insurance Companies are putting forward an abundance of schemes. The Act involves so many new risks, and its working and interpretation are so doubtful, that it is not surprising that the Companies have only recently got their rates and prospectuses ready. We doubt if an Act of so much importance, involving so many interests, has ever before been passed with so hazy a conception on all hands of what it means. The chief point upon which people seem agreed is that, while it was intended to minimize litigation, it is certain to lead to an exceptionally large amount of legal disputing.

Up to the present, controversy has chiefly raged round the question of rates, which, as quoted by the Insurance Companies, are greatly in excess of those contemplated by the promoters of the Act. The Insurance officials have collected all available data, estimated as well as possible the meaning of the Act and the liabilities imposed, and then deduced their rates on recognized principles. It must, however, be noted that the data upon which they have worked is not completely trustworthy—not for lack of care or study on their part, but simply because new conditions are involved, and experience in regard to them is consequently non-existent. For either side to say dogmatically that their rates are right and other rates wrong, is, of course, foolish; but it must be admitted that the leading Companies have considered the matter with the greatest care, and have made out a very good case in justification of the high rates they at present feel themselves bound to charge. Only one remedy seems to exist for this ambiguous state of affairs, and that is a fair system of profit-sharing between the offices and the employers.

Such a system is being put forward by some of the best Companies transacting this class of business, and notably by a combination of four of the principal Offices that has just been announced. The Guardian Fire and Life Assurance Company, the Law Union and Crown Assurance Company, the Rock Life Assurance Company, and the Sun Life Assurance Society have made a mutual arrangement for insuring, on a profit-sharing basis, the owners of collieries, mines, and quarries, against the liabilities imposed upon them by the Workmen's Compensation Act, 1897, the Employers' Liability Act, 1880, and by common law. The risks that such owners as these are subject to, owing to the possibility of great catastrophes, is very large; and in order that insurance in such cases should really insure, exceptional financial strength is required to be provided. These four Companies together possess paid-up capital exceeding £2,750,000, an annual income exceeding £2,250,000, uncalled capital of £3,950,000, and total assets of £16,000,000. Their dates of formation are respectively 1821, 1825, 1806, and 1810, and they rank among the strongest and wealthiest Insurance Companies in Great Britain. The importance of not merely present financial strength, but of a future as to which no doubt exists for a moment, cannot be over-estimated by an employer in selecting an office in which to insure against the heavy liabilities to which he will shortly be subject. The combination of the four Offices only applies in connection with collieries, mines, and quarries; and it is obvious that no single company is in a position to offer anything like the financial strength of such a combination. Taken separately, each of the four is either financially stronger, or has been longer in existence, or both of these, than any of the other Offices transacting this class of business; and it would seem probable that the whole of the colliery, mine, and quarry-owners in the kingdom will recognize the exceptional advantages afforded by the combination, and will place all their insurance with it.

The system of profit-sharing adopted by the combination seems exceptionally favourable to the insured. They issue a form of statement of account for determining the premiums returnable to the employers. On

the debtor side appears the amount of the premium; on the creditor side, a statement of claims, of medical charges, and expenses of litigation, arbitration, or other legal proceedings; and of expenses of management, which are limited to 15 per cent. of the premiums. In addition to this, 10 per cent. of the premiums is taken for profit, 5 per cent. is set aside to form a catastrophe fund, and the balance is returnable to the employers. Thus, for expenses and profits, the Companies only take 25 per cent. of the premium income. When we remember that the expenses of the Fire Offices amount, on an average, to 34 per cent. of the premiums, and those of the Accident Offices to an even higher percentage, this fixed charge of 25 per cent. in all strikes us as extremely moderate; and the scheme, as a whole, effectually solves in the most equitable manner the question of the rates it is appropriate to charge.

It may be added that a few weeks ago we received from Mr. J. E. Rideal, of 72 and 73, Gracechurch Street, whose letter on the subject dealt with in the preceding article appeared in the "JOURNAL" for the 14th inst., a scheme of profit-sharing in conjunction with insurance on the lines indicated. He proposed that 25s. per cent. on the amount of wages should be paid as the tariff rate of premium, and that at the end of each twelve months there should be a settlement in accordance with a statement of accounts prepared as set out below. The minimum amount of wages was to be £100,000; and from the rate named there was to be a discount of 10 per cent. He pointed out that under his scheme the parties could not pay more than the tariff rate; and if their business proved remunerative, they would get all the profits less 10 per cent. of the net premium. The expenses of management would be at a fixed rate; and there would be a considerable saving as compared with undertaking the risk themselves, as well as in settlement, as a company could, he remarked, always settle a claim, and with equity, so much better than an employer direct.

Statement of Account for Determining Profits Returnable to Employers.

Dr.

To gross premiums	£
Less discount of	
Net premium	£

Cr.

1.—By claims paid and discharged	£
2.—By claims not discharged—	
(*a*) DEATH—for claims not discharged of representatives wholly dependent (three years' wages according to the Act)	
(*b*) DEATH—for claims not discharged of representatives partially dependent (estimated according to dependency)	
(*c*) PERMANENT DISABLEMENT (cases which we have failed to commute by payment of lump sum)—the capital value of the allowance according to the age of claimant, calculated at 2½% interest, less any sum already paid	
(*d*) TEMPORARY DISABLEMENT—a sum based on the Medical Officer's estimate of the probable duration of the disablement, less any sums already paid	
3.—By expenses of litigation and arbitration, or other legal proceedings, paid and estimated to be paid	
4.—By expenses of management, including—	
Medical charges	
Inspection charges	
Observation charges	
Clerical charges	
Control charges	
A rate of 15% of the net premium)	
Total charges	£
5.—By profit of Society (10% of the net premium)	
6.—By balance being premium returnable to employer	
	£

THE WAGES OF GAS-FITTERS AND LAMPLIGHTERS.

An interesting summary of the wages paid to these operatives in different boroughs has been obtained for the information of the Stafford Corporation, as the result of a motion to grant an increase of wages. The figures were collected by Mr. J. Ferguson Bell, the Gas Engineer; and from them it appears that for gas-fitters the average rate of pay for twenty towns was 6·82d. per hour—the present rate in Stafford being 7d. The time worked varied from 50 to 60 hours per week; the average at Stafford being 53½ hours. Mr. Bell obtained from Bilston, Birmingham, Burton-on-Trent, Chester, Coventry, Derby, Dudley, Fenton, Hereford, Kidderminster, Leicester, Longton, Stourbridge, Shrewsbury, Stoke-on-Trent, Tipton, Walsall, West Bromwich, Wolverhampton, and Worcester, particulars as to the hours of labour of, holidays allowed, and wages paid to, gas-fitters and lamplighters. For gas-fitters the rate of pay varies as follows: In three towns the rate is 8d. per hour; in one, 7½d.; in eight, 7d.; in one, 6¾d.; in one, 6½d.; in four, 6d.; and in one, 5¾d. The average is as stated above. With regard to lamplighters, the rate of pay per week varied as follows: In one town the wages varied from 24s. 6d. to 21s. per week for 92 lamps; but the lamplighters have to work two days each week in the yard or at the purifiers. In one town the rate is 23s. 4d. per week for 100 lamps; in one, 22s. for 110 lamps; in one, 22s. for 111 lamps; in three, 21s. for 100 lamps; in one, 23s. to 20s. for 88 lamps; in one, 20s. 9d. for 110 lamps; in one, 20s. for 100 lamps; in one, 20s. for 90 lamps; in one, 20s. for 85 lamps; in one, 19s. for 100 lamps; in one, 17s. for 70 lamps; in one, 16s. for 75 lamps. The average rate for fourteen towns is 20s. 4½d. per week; and the number of lamps averages 94. The present rate of wages for lamplighters in Stafford is 24s. per week; and they attend to an average of 98 lamps per man. It has been decided by the Stafford Corporation to pay the gas-fitters 7½d. per hour, and the lamplighters 26s. per week.

ELECTRIC LIGHTING NOTES.

The Morley Corporation Electricity Works were formally opened last Friday by Alderman S. Stockdale, the Chairman of the Electric Lighting Committee. The works have been constructed at a cost of £21,219.

The electric lighting works of the Wakefield Corporation were formally opened on the 15th inst. by the Mayor (Mr. A. W. Stanfield). At the present time, they are equal to the supply of 30,000 lights; and the buildings have been so arranged that the plant can be readily duplicated for supplying double the present number of lights.

The Tipton District Council have adopted an agreement with the Midland Electric Corporation, by which they will withdraw their opposition to the application of the latter to the Board of Trade for a Provisional Order. Under the agreement, the maximum price for the supply of electricity in bulk is to be 3d. per unit; and the Council will have the option of appealing to an arbitrator twelve months after the passing of the Order to determine whether or not this is a fair price. The price is also subject to revision every seven years.

The Geneva Correspondent of the "Financial News," writing on the 18th inst., said: "The great Swiss Electrical Trust, projected already for some time past, has now been called into life, with a capital of £1,000,000, of which £600,000 has been taken over by the Banque de Paris et des Pays Bas; and the remainder by the Union Financière. The objects of the new venture would seem to be sufficiently indicated by its title; but it should, perhaps, be added that not only Switzerland, but France, will be included in the field of its operations." The offices are to be in Geneva, in order to preserve the Swiss character of the undertaking.

At the meeting of the Court of Common Council last Thursday, Mr. Brooke Hitching moved: "That it be referred to the Streets Committee to consider and report as to the desirability of approaching the City of London Electric Light Company, Limited, with a view to the acquisition by purchase of so much of that Company's undertaking and plant as is situated within the City, together with the Company's electric light generating station in Southwark." He said the supply of electric light was undoubtedly profitable; and it would be necessary, if the Company agreed to sell their rights, for the Corporation to expend a considerable sum of money on the matter. But if it could be proved that the purchase would result in a large profit, as had been the experience in other places, there should be no difficulty. Mr. Turner seconded the motion, which, after some discussion, was withdrawn in favour of a resolution referring the whole question of the electric lighting of the City to the Streets Committee for consideration and report.

When the Exeter City Council acquired the electric light undertaking from the Company, they applied to the Local Government Board for leave to borrow £11,000, of which £7500 was the purchase money, and the remainder was required for additional works. The £3500 was not sufficient, for no sooner had the Council purchased the undertaking than the demands for the electric light increased considerably beyond what was contemplated. Consequently an additional expenditure of £1104 over the estimate was incurred. Since July 1, 1896, there had been an increase of more than 50 per cent. in the number of lights; and in the year and a half ending Dec. 31 last, the undertaking has not only paid all its working expenses, but has also paid interest and sinking fund, and left a balance of £825. Under these circumstances, it was necessary to extend the works; and the Council therefore recently applied to the Local Government Board for sanction to the borrowing of £7000. The customary inquiry was held by Colonel Ducat last Thursday, when the Town Clerk (Mr. G. R. Shorto) made a statement in which he gave the above and other particulars showing the necessity for the enlargement of the works. Mr. T. Letheren opposed the application so far as the loan referred to new machinery, on the ground that the present station was not suitable for the purpose. The Inspector reminded the Town Clerk that in May, 1896, Professor Fleming gave it as his opinion that the present station was out of date, to which Mr. Shorto replied that the Professor had since had occasion to modify that view—the efficiency of the station having been greatly improved. The Inspector subsequently visited the works.

In response to an advertisement, the Ipswich Corporation lately received seven offers from electric light and plant companies for giving effect to the powers contained in their Electric Lighting Order. The proposals were submitted to Professor Kennedy, who came to the conclusion that he could not advise the Corporation to accept any of them. His reasons were that, by adopting any one of the proposals, the Corporation would be entirely tied to the same manufacturer and plant, without any practical control over them, for a number of years. At the end of that time, the Corporation would have to take over the station, whether the system used had been successful or not, and would have to pay for it a sum which would amount in most cases to anything from 30 to 50 per cent. more than they would otherwise have paid, not only for the first instalment of plant, but for all the plant required up to the date of taking over. Professor Kennedy concluded by saying that, on the whole, he distinctly recommended the Corporation to keep the Provisional Order in their own hands, and have it worked out by an engineer in the usual way; so that the whole control of the undertaking might remain with them from the beginning. At the meeting of the Corporation last Wednesday, the Electric Lighting Committee recommended that they be empowered to take the necessary steps to carry out the powers conferred on the Council by the Provisional Order. The Deputy-Mayor (Mr. G. F. Josselyn), in moving the adoption of the report, said Professor Kennedy had already estimated that the cost of the installation would be £41,700; and when they deducted from this £5700 for street lighting, the total would be reduced to something like £36,000. Both the Committee and Professor Kennedy agreed that there was little prospect of street lighting by electricity being undertaken, because the narrow streets of the town were ill-adapted for arc lights. Therefore, except, perhaps, in public places, electricity could not be applied to their streets. They might bear in mind, also, that electricity, by the natural process of competition, would probably enable them to get better terms from the Gas Company, although he was ready to admit that the gas supply of the town was excellent. The motion was carried.

The proposed utilization of the compensation water at the disposal of the Water Committee of the Sheffield Corporation for the purpose of generating electricity for tramway traction has been pronounced by the expert consulted by the Council (Mr. F. Nell) to be impracticable. In view of the interest attaching to the question, we give the main parts of

his report. Referring to the Damflask reservoir, he says that, being employed solely for compensation water, its use would not at present interfere with the supply to the town, but would necessitate buying out or compensating the eleven mills situated on the River Loxley. The difference in level between the sill of overflow at Damflask to the level of the river at Malin Bridge is 275 feet in a distance of 3¼ miles; but seeing that in dry seasons the dam would be drawn down, and taking into consideration the fact that it will be necessary to maintain the head constant so as to give a regular speed to the dynamos, it would be well to deduct the depth of the reservoir—viz., 85 feet—which would reduce the working head to 190 feet. The compensation available from this source is 25½ cubic feet per second, or 1530 cubic feet per minute for twelve hours per day for six days per week. But Mr. Nell assumes that the tramway would require power for sixteen hours per day and seven days per week; consequently the available quantity of water per minute would be reduced in order to meet the requirements of a greater number of working hours—viz., 112 per week, as against 72 at present. Therefore the quantity of water available per minute for 112 hours per week would be 950 cubic feet. The existing 24-inch pipes would not be suitable for passing this quantity of water, as the loss through friction would be too great. It would consequently be necessary to lay a new pipe-line 30 inches in diameter, which would pass the 950 cubic feet of water per minute at a velocity of 3½ feet per second, and would occasion a loss of head due to friction equal to 35 feet, which would reduce the working head to 155 feet. Under this fall of 155 feet and 950 cubic feet per minute, 198-horse power could be obtained for a working day of sixteen hours for seven days per week. It will, therefore, be seen that to develop this power would necessitate laying down about 3¼ miles of 30-inch pipes at a cost, roughly speaking, of about £18,000. In addition to this, there would also be the cost of the turbine—say, £500—and the expense of compensating or buying the mills on the Loxley. As to the Rivelin reservoir, the difference in level between the depositing pond and the river at Malin Bridge is 304 feet; and the quantity of water, 14 cubic feet per second, or 840 cubic feet per minute. The pipe-line required to pass this water would be 28 inches in diameter, and would cause a frictional loss of 44 feet; thus reducing the working head to 260 feet. The 840 cubic feet of water under this head of 260 feet would develop 330-horse power. There would also be the expense of compensating or buying the mills on the River Rivelin; and the pipe could be estimated at a cost of about £20,000, with an additional £450 for the turbine itself. He does not think anything could be done with the Redmires reservoir, as nearly the whole of the water is required to supply the high service of the town.

BRISTOL CORPORATION AND THE WATER-WORKS.

At the Meeting of the Bristol Town Council last Tuesday, the Committee who were deputed some time since to consider the question of purchasing the water-works reported that the Directors of the Company were not prepared to negotiate for the sale of the property. In moving the adoption of the Committee's report, Alderman Davies said that at the time of the appointment of the Committee, there were several important matters before the Council; and it was thought that there would be intricate and involved negotiations with the Company. Otherwise, if they had known that the matter would have been so summarily disposed of, they would have reported earlier. In 1878 there appeared to be every prospect of the city acquiring the water-works; and it was hard to understand why the negotiations broke down. There seemed to have been some power behind the scenes, which was not apparent in the published report to the Council; and it was a matter of extreme regret that the opportunity was lost. In 1880 negotiations were again entered into. But at that time certain prominent members of the Council were interested in a new Company to utilize the Sudbrook spring; and the Directors of the Bristol Company apparently did not deem the time opportune to negotiate. Since then the Company had made large contracts; and it would require the very serious consideration of the Council before they authorized the Committee to seek to obtain parliamentary powers. They would have to show Parliament, perhaps, that the quality of the water was inferior—and he did not think anyone could say it was—and that the supply was inefficient. In view of the large works which the Company had undertaken, he did not think they could make out a case; and then no doubt they would have to pay a sum largely in excess of the nominal value of the shares. In all probability the transaction would not prove profitable to the city. He was quite of opinion that the works ought to have been acquired by the city; and if they could have come to terms with the Company, the case would have been different. Mr. Pearson seconded the motion to adopt the report, but for reasons diametrically opposed to those of the last speaker. In his opinion, Parliament favoured corporations owning such monopolies as water; and he believed that if the time arose—and he thought it would arise—when they had to deal with this question, they would find that the difficulties were not so great as Alderman Davies imagined. Alderman P. Baker, who took a leading part in the negotiations of twenty years ago, said the hidden power to which Alderman Davies referred was the pressure of public opinion outside the Council Chamber. Mr. Levy thought it a pity that the Council could not get the undertaking into their hands. But failing this, they might bring pressure to bear upon the Company to reduce their "extortionate" charges. Mr. Barnett spoke in favour of keeping the question alive, and moved, as an amendment, that the Committee be requested to report, firstly, if any reduction in the present charges could be enforced, with power to take Counsel's opinion thereon; secondly, as to the various charges now imposed for the supply of water, and a comparison of them with charges enforced in other large cities; and generally to advise as to the supply of water, to which Alderman Davies said he had not the slightest objection. Mr. Spofforth suggested that the Committee should try to ascertain the price that would be demanded by the Company for the works. Mr. Tryon pointed out that the capital of the Company was £1,700,000, and the premium £1,250,000. Mr. Pearson appealed to Mr. Barnett to withdraw the amendment, and bring the matter up in another form for the consideration of the Council. Unless they were prepared to deal with the matter seriously, these inquiries would be idle. The amendment was carried.

METROPOLITAN WATER SUPPLY COMMISSION.

Twenty-sixth Day—Monday, June 20.

(*Viscount* LLANDAFF, *Chairman, Major-General* A. DE COURCY SCOTT, R.E., *Rt. Hon.* J. W. MELLOR, Q.C., M.P., *Mr.* A. DE BOCK PORTER, C.B.)

The sitting took place at the Guildhall, Westminster.

The following Counsel are engaged: Mr. POPE, Q.C., and Mr. CLAUDE BAGGALLAY, Q.C., for the New River Company; Mr. LITTLER, Q.C., and Mr. LEWIS COWARD for the Kent Water Company; Mr. PEMBER, Q.C., for the Lambeth, East London, Grand Junction, and West Middlesex Water Companies; Mr. RICKARDS for the Chelsea Water Company; Lord R. CECIL for the Hertfordshire County Council; Sir JOSEPH LEESE, Q.C., M.P., for the Kent County Council and Kent Local Authorities; Mr. BALFOUR BROWNE, Q.C., and Mr. FREEMAN, Q.C., for the London County Council; Sir R. NICHOLSON for the Middlesex County Council; and Mr. GABRIEL P. GOLDNEY (Remembrancer) for the Corporation of the City of London. The Southwark and Vauxhall Water Company are represented by Messrs. BIRCHAM AND Co.

Mr. *W. C. Leete*, Vestry Clerk of St. Mary Abbott, Kensington, examined by the Chairman, said the parish of Kensington comprised an area of 2245 acres, and contained 22,000 inhabited houses and a population of 170,000. The rateable value was £2,107,894. The Vestry had had before them, during recent years, the question of the water supply of the Metropolis, particularly in connection with the Bills which have been promoted by the County Council for the acquisition of the Water Companies. The Vestry had, on more than one occasion, expressed their disapproval of purchase by the Council, and had favoured rather, as an alternative policy, legislation by which a central body, representing the water consumers of the whole area, should be vested with powers of control and supervision of the undertakings of the Companies. On Jan. 16 and May 8, 1895, the Vestry passed resolutions, the object of which was to obtain for the representatives of the ratepayers such sufficient control and supervision over the whole water supply of the Metropolis as would, without necessitating the purchase of the undertakings, give to the consumers, by powers to be obtained from the legislature, a directing influence in regard to all schemes for the extension of supply in the future, as well as statutory powers for regulating the system and manner of distribution, such as Parliament had in times more recent to the granting of Water Acts imposed on similar private undertakings for public purposes. The body to be created should be vested with powers regarding matters such as future supply and intercommunication between the systems of the several Companies.

The CHAIRMAN: Do you propose that the central body shall have power to order the Companies to go to Wales, for instance?

Witness: I think they ought certainly to have the power to bring before Parliament the desirability—if they deemed it desirable—of extending the supply, whether from Wales or any other source. The body would not be vested with administrative power to themselves compel the Companies to go to Wales, but merely to bring the matter before Parliament by Bill. Of the two policies before the Commission—purchase or more effective control—the Vestry favour the latter. The central body might be representative of the Water Companies, the Local Authorities, or the County Council; but I cannot say exactly what they would do. The central body should certainly have power to inspect the works of the Companies.

Then suppose they came to the conclusion that a wise thing for London was to go to Wales, you propose nothing more than that they shall have power to bring in a Bill to compel the Companies to do so?—I do not suppose the Legislature would ever vest in the body absolute power to go straight off and bring in a supply from Wales.

Mr. DE BOCK PORTER: Are they to be merely an advisory body, or are they to have control?

Witness: That would be a question for Parliament. It might be advisory, and might also have some control.

Do you suggest that this central body should have power to alter the statutory charges of the Companies?—I take it there would have to be further legislation, because the repeal of some existing enactments would be necessary.

The CHAIRMAN: Can you tell me on what ground the Vestry object to the policy of purchase?

Witness: They are in some fear of the financial results. I do not say their view might not be materially altered if the Commission came to the conclusion that the ratepayer would be amply protected. At present, they fear there is not sufficient evidence before the public to show that it would be a saving to the ratepayers—that there might not be an additional charge to the consumers. The Vestry would, of course, strongly object to anything like a rate-in-aid. Taking the last fifteen years, the rateable value of Kensington has largely increased.

Have the Vestry acquiesced in the whole of the additional value going to the Water Companies rather than being used for the public advantage?—I think they consider that at present the Companies are getting the best of it in certain areas. The assessments on existing properties in Kensington are undoubtedly decreasing, but the rateable value of the parish is rising, owing to substitutions and new properties being brought into rating. But for the public undertakings, the valuation in 1895 would have shown an actual reduction of £50,000. Old property in Kensington is being largely replaced by flats.

By Mr. PEMBER: He could not say that, in the case of an owner of flats paying the water-rate, the percentage of charge was reduced.

The CHAIRMAN: I see you have had a dispute with the Grand Junction Water Company as to their charges for non-domestic purposes?

Witness: Yes.

I am afraid we cannot go into that, as it is not in our reference; I will only get the broad fact. I believe you found, on inquiry, that the Company were probably justified by their statutory powers in what they did?—That is so.

Your complaint was rather of the privileges Parliament has given them than of the action of the Company themselves?—It was a statutory power which they possessed, and which we thought rather a dangerous one in the hands of the Company. The complaint arose out of what the Vestry believed to be the fact—viz., that the Company, in case of a trade supply,

could compel the use of a meter and charge 9d. per 1000 gallons for a minimum of 100,000 gallons, whether this quantity were taken or not. This seems to be a power possessed only by the Grand Junction and West Middlesex Water Companies. The Vestry also complained of the power the Companies had of cutting off the water supply in order to compel payment of their charges; holding that this power should be taken away altogether. It is an anomaly that a Water Company may create what another statute says is a nuisance—namely, a house without water.

By Mr. PEMBER: He agreed that the local Medical Officer of Health gave a very good character to the water supply. Neither as to the constitution of the new body, nor as to its functions, had the Vestry considered the subject. The Vestry were also in favour of the equalization of charges. The rates of the Companies were in the main alike; it was only, he believed, in regard to some of the minor charges that friction arose. The equalization would certainly be in a downward tendency. He had no evidence that any of the Companies had exercised their powers immoderately. Equalization of rates down to the lowest, would bring them within very little of a rate-in-aid. The rates in Kensington were now about 5s. 10d. in the pound.

By Mr. H. L. CRIPPS (in the absence of Counsel representing the London County Council): He agreed that the charges on rateable value in Kensington were much less than for houses of similar rateable value in the East and South-west.

Mr. PEMBER remarked that if they found a house of £200 rateable value in Lambeth, it would be exceptional, and in Kensington it would be worth three times as much, though only consuming the same amount of water.

Witness: A resident in Kensington would undoubtedly pay more per gallon than a resident in the East of London, although the West Middlesex Company's charges are much lower.

In answer to further questions, witness admitted that the Vestry, in 1891, petitioned in favour of the Metropolis Water Bill, under which there was to be purchase, with the London County Council as Trustees.

Mr. *John Collins*, examined by the CHAIRMAN, said he was a member of the Whitechapel District Board of Works. He lived at No. 32, Crispin Street, Spitalfields, and carried on business as a basket maker at No. 31; while his wife conducted a laundry at No. 33. He gave evidence at length regarding the failure of the supply by the East London Company in the summers of 1895 and 1896. In July, 1895, without any notice being given, the constant supply was reduced to a supply of about two hours daily.

Mr. PEMBER said in 1895, from July 15 to 25, water was supplied during two hours daily; from the 26th to the 30th, during three hours; from July 30 to Aug. 17, during six hours; and from Aug. 18 to Sept. 8, during eleven hours. After this the constant supply was restored.

Witness: I do not agree. The hours were of shorter duration.

Mr. PEMBER: I know evidence of that kind was given before the inquiry at Hackney; but it was not believed, because, as a matter of fact, it was not true.

Witness (continuing) said the supply was given during about two hours in the morning and two hours in the evening. It never exceeded two hours. No notice was given as to the length of the supply nor when it would be given. It was very hot weather; but he did not suppose there was a drought, seeing that the other Companies were not in difficulties. In 1896, the complaint was more serious than in 1895. Having been altogether without water for several days, he applied to the turncock, who said he had orders to allow water to run only two hours a day. In 1895, action had been taken, witness believed, to test the rights of the Company in the Courts; and the action was dismissed on the ground that, the water-rate not having been paid in advance, they had no legal right to demand what they had not paid for. Witness therefore went to the office of the Company and paid his rate till the following Christmas. He thereupon saw someone in authority, who said he would attend to the matter. The next day the supply was only turned on for two hours. With the object of compelling the Company to fulfil their obligations, witness went to Mr. Cluer, the Magistrate, who, after hearing him, said witness evidently had a case; but as the weather was hot, and there was a drought, and the Company could not supply what they had not got, he advised civil proceedings. Witness, however, could not afford to take that course, and so he went on suffering. He succeeded in calling a special meeting of the Whitechapel Board; and in the end a deputation waited upon the Company. As a result, a few more stand-pipes were put on; but the hours of supply were not extended. The explanation given by the Company was that the supply ran short through the drought. No abatements were allowed in rates consequent on the inadequate supply.

The CHAIRMAN: Have you any persons in the Whitechapel district supplied by meter?

Witness: Yes.

Was their supply shut off?—For a short time. They pointed out the injury and inconvenience that might accrue through non-supply, and it was then continued.

The supply by meter was continued, although that for domestic purposes was cut off?—Yes. It was necessary that the meter supply should be continued in cases where there were boilers, &c.

Mr. PEMBER: All this was asserted in the great inquiry; and it was all disproved.

Witness (continuing) said the Company issued two notices with regard to cisterns, the second of which directed the people to supply themselves with cisterns—which had been abolished years before on sanitary grounds. When the Company said they would supply more stand-pipes, the Board were of opinion that this was as far as they could require them to go; they never thought of suing for penalties, or of applying to the London County Council for help.

The CHAIRMAN: Are you aware that there are statutes which compel the Companies to give a constant supply, under heavy penalties?

Witness: I was under that impression.

And the Board accepted the position of your being hopelessly in the power of the Companies?—Yes.

Mr. CRIPPS said that the County Council were advised that they could do very little in the matter. It was doubtful if the Company would not be saved by the clause in their Act which relieved them in case of drought or frost.

In further examination, witness said he had no knowledge of the Metropolis Water Act of 1897, nor that a local authority under it could take up the grievance of a consumer. He also knew nothing of the Act of 1852, under which the Company might have been sued for a £200 penalty.

By Mr. PEMBER: There was a very long inquiry in consequence of what happened in 1895; but no representative of Whitechapel was present. Witness tried to persuade the members, who were chiefly property owners, to send one; but they declined. Witness saw none of the notices issued by the East London Company until about seven days after the supply was shut off. Though the learned Counsel produced one dated July 12, witness adhered to his statement that the notice he saw was not dated.

Mr. PEMBER then read at length, as a reply to the allegations of the witness, from the proceedings in connection with the inquiry in 1895. Practically, he said, at this inquiry it was accepted that no undue preference was shown on behalf of any consumers. As to storage, the passages read indicated the steps taken by the Company to provide it, and the opposition of the County Council to these steps; and they then stated that the responsibility for the want of storage could not be saddled on the Water Company. The report stated that the scarcity of water in the East London Company's area in the summer of 1895 was due to exceptional waste, which was beyond that of ordinary years—due, first, to the non-repair of fractures in the consumers' pipes brought about during the unusually long and severe frost of the previous winter; and, secondly, to excessive garden watering during the drought. Another reason of the scarcity was the decreased volume of the River Lea during the unprecedented drought which occurred in the first six months of 1895; and a third reason was that the storage of the Company was inadequate to meet the waste of water already indicated. The same main causes, except frost, that operated in 1895, were in operation in 1896.

The CHAIRMAN said the evidence of the witness only related to the question of control. As he read the Act, it was in the power of the District Board to prosecute the Company for failure of supply. He could not make out why they did not do so.

Mr. CRIPPS said it would have been extremely difficult to prove.

Mr. *R. D. M. Littler*, C.B., Q.C., the Chairman of the Middlesex County Council, who was examined at the previous sitting, was now further examined.

Mr. DE BOCK PORTER: I have a question to ask you—whether the Middlesex County Council are of opinion that the additional income derived from the constantly increasing assessments of properties in the Metropolitan area should inure to the benefit of the Water Companies rather than be utilized for the making of better, and if possible more economical, provision for the consumers in the Metropolis?

Witness: As far as we are concerned, there is a large increase of rateable value going on. But it is mainly in small houses; and I should say that probably, gallon for gallon, the Water Companies are getting considerably less out of Middlesex than they were twenty years ago, though they are getting more collectively. The rateable value of Middlesex has increased; but the consumption has increased much more largely. I have a letter from the Willesden Urban District Council, disagreeing with the evidence I gave last week; and stating that they favour purchase, and approve of the Companies' undertakings being vested in a Water Trust for London and Water London.

By Mr. BALFOUR BROWNE: The Middlesex County Council had taken every means to ascertain the feelings of the various Local Authorities in the county regarding the water question.

Mr. BALFOUR BROWNE: Do you know that Tottenham is opposed to your view?

Witness: I am certain it is not.

Do you know that in 1895 they gave evidence in favour of purchase?—Unless I actually saw the evidence, I should doubt it.

Witness was then questioned as to whether his views as Chairman of the Middlesex County Council were the same as his views as Counsel for the Kent Company. He said that, as Counsel, he represented to the best of his ability what was contained in his instructions; but he absolutely declined to give the learned Counsel the contents of his brief. Even if Middlesex could get the water supply into its own hands without loss, he did not know why they should prefer to manage their own water affairs instead of having them managed by Directors of a Company. The Council would have the trouble of doing the work. He was willing to work if he could get any advantage; but if there was to be no advantage arising from the transfer, he should object to it. Witness being opposed to a Water Trust and to purchase, he was pressed to suggest some additional form of control; but he declined, saying if any form of control were suggested to him he would give his opinion on it. He agreed that the tendency now was to transfer gas and water undertakings to municipalities. He did not know of a water arbitration where there were overlapping areas. The fact that the areas in London overlapped would, like every other circumstance, be considered by the arbitrator.

Mr. BALFOUR BROWNE: You are absolutely against more water being taken from the Thames or from the County of Middlesex?

Witness: No; I am against water being taken from the Thames beyond the existing quantity, so long as sufficient is not left for the County of Middlesex. I am in favour of as much water being taken from the Thames as can be got without injuring the navigation on the river; but of that water, I want it to be perfectly clear that sufficient is left for my county. I should object altogether to more wells being sunk in Middlesex for the supply of anyone outside.

Do I understand that you object to any special instruction being given to the arbitrator; and that you object to sell, because if there is no special instruction you will have to pay too much?—I do not object to any special instruction as a ratepayer; but I cannot assume that Parliament will do with a water company anything different from what they do with any other company who are working well. I should support, as a ratepayer, every conceivable clause being put in which would depreciate the property; but in this case I assume Parliament would give the proper value on the principle recognized ever since the Lands Clauses Act was passed. The proper value is the value to the seller; and this looks very like what he could get for a particular share. If he could obtain £300 in the market, I do not understand why he should have less because he sold in company with other shareholders instead of by himself.

Your idea was that, under the Lands Clauses Act, the Companies would get an allowance of 10 per cent., in addition to the value of the under-

takings?—The only cases in which I have known it not got have been, in one instance, where they were very anxious to sell (they were a non-statutory company, also), and even then there was a very large number of years' purchase given; and in the other, where the companies absolutely misbehaved themselves, and they could give no more water.

Are you not aware that, in a great number of cases, the allowance for compulsory sale is absolutely prohibited?—I should like to know a water case in which it was not given.

Witness was then plied with a good many questions, relating to calculations based on purchase at 28½ years, which figure, Counsel held, witness had given as the probable number in the case of the London Water Companies. Witness, however, emphatically denied that he had given the figure in this connection. Unquestionably, the London Water Companies would fetch much more—more likely 35 years. Not even the Southwark and Vauxhall Company could be bought for 28½ years' purchase.

Mr. Balfour Browne: Will you tell me of a single company that has been sold at more than 28½ years' purchase on existing income?

Witness: I do not know of one off-hand; but I am perfectly certain I could find half-a-dozen. It is common enough knowledge that more than that is given by agreement. I do not agree that, as regards future capital, there would be a saving, if the money were raised by the County Council, of 7s. 6d. per cent.

By Lord R. Cecil, on behalf of the Hertfordshire County Council: If the London County Council purchased and supplied Middlesex in bulk, he should want some control over London very much stronger than anything that had yet been suggested.

The Commission then adjourned.

The twenty-seventh sitting of the Commission was held yesterday, at the Town Hall, Westminster—Viscount Llandaff presiding. Mr. J, Bigwood, M.P., Alderman of the Middlesex County Council, and Chairman of the Parliamentary Committee of that body, said the New River Company was the only one of the three Metropolitan Water Companies—the New River, the West Middlesex, and the Grand Junction—supplying in Middlesex, that had wells in the county. It was a very great question whether the Company had statutory rights to sink new wells. He understood that it was as landowners that they drew water from the wells. He was strongly in favour of the maintenance of the *status quo* as regarded Middlesex, subject to there being some further control on behalf of the consumers and the Local Authorities.

CHELSEA WATER-WORKS COMPANY.

The Half-Yearly General Meeting of this Company was held last Thursday, at the Offices, Commercial Road, Pimlico, under the presidency of Mr. F. S. Clayton.

The Secretary (Mr. G. H. Gill) read the notice convening the meeting, and afterwards the certificate of the Government Auditor, and the report of the Company's Auditors. The latter certified that the accounts and balance-sheet for the half year ended March 31 last were duly supported by vouchers, and were correctly deduced from the Company's books. They had great pleasure "in again expressing their entire satisfaction with the clear and precise way in which the accounts had been kept; the more so taking into consideration the constant increase of work in the Accountant's department."

The Governor, in proposing the adoption of the report, remarked that it opened with a very sad announcement—namely, that since the last half-yearly meeting two highly-valued members of the Board had died—Mr. John Stone-Wigg and Sir William Henry Wyatt. Mr. Stone-Wigg had been a Director of the Company for nearly 18 years. He was a man of large business capacity; and his opinions were always listened to with great respect by his colleagues on the Board. Sir William Wyatt had held the office of Governor for nearly 17 years, and was a member of the Board for about 26 years. It was unnecessary for him to dwell upon Sir William Wyatt's great abilities, and his special qualifications for the position he had held in the Company. There was little doubt that during the time he was at the head of affairs, the financial position of the Company prospered in a very marked degree. With regard to their business, the gross income for the half year had amounted to £82,048, which was an increase of £2095 as compared with the corresponding period of last year; and the working expenses had been £27,023—being an increase of £1069. This included an increase of £620 under the head of filtration, due principally to expenditure on sea-sand, which was a new ingredient in water filtration, and an ingredient from which they believed a considerable improvement in their filter-beds would result. The rates and taxes also showed an increase of £818; but this was rather abnormal, and was owing to a little overlapping in regard to one of the parishes. The increase on the year amounted to only £376. With reference to the subject of rates and taxes, it might be interesting for him to mention that the amount paid by the Company under this head for the year ended March 31 last was £15,071, which was equal to 2 per cent. on the ordinary stock of the Company; or, to take it in another way, it was equal to 9½ per cent. on the gross income from water-rates. All this went into the pockets of the public; and it was a fact which was not sufficiently borne in mind by many of their critical friends. The expenditure on capital account for the half year had amounted to £5386, of which £1851 they might say was productive outlay, as it was expended for ordinary extensions of service-mains in the district. This, of course, meant more revenue. The remainder of the amount was expended partly on account of easements under the Company's Act of 1896—that was, the right to lay the mains authorized under their Act of Parliament—and also partly in respect of clearing up matters on account of the new filter-bed and the laying of the main. It was interesting to note, as one effect of laying this new main, that the Company were now in a position to send out the whole of their water from the intake at West Molesey to the works at Surbiton by gravitation. As they said in the report, a saving of nearly £400 in pumping had thus been effected. This was very satisfactory. It was often said that laying a main was an unproductive expenditure of capital; but this had not been so in the present instance. There had been 87 houses pulled down in their district—principally in Westminster; and this would involve a temporary loss of income of £274. But they had a shrewd idea that the old houses would be replaced by ones of a much more important character, which would bring in a larger water-rate than before. Constant supply had been extended during the half year on the requisition of the London County Council; and at the present time 99 per cent. of the Company's supplies were on this system, and the remaining 1 per cent. would be put upon it, they believed, in the course of next September. The whole of the Company's water supply would then be on the constant system—a circumstance of considerable interest not only to the Company, but also to the public, who, he hoped, duly appreciated the fact. He had to refer to another matter of, he might say, serious importance to them—namely, that they contemplated a considerable outlay on improving their works. In the first place, the Board had decided on increasing the storage capacity of the subsidence reservoirs at West Molesey by raising their banks 5 feet, whereby an increased storage of about 50 million gallons would be obtained. The reservoirs had at present a capacity of 140 million gallons; so that when their banks had been raised 5 feet, he took it they would have something like 15 days' supply on the present daily average of 12,300,000 gallons. This would be a very satisfactory state of things. A contract had already been entered into with the firm of Messrs. Thomas Docwra and Son for carrying out this important work for £29,442. Further, the Directors had decided on improving and extending the reservoir capacity for filtered water at Putney Heath. Fortunately for the Company, they possessed spare land in the locality which was admirably adapted for the purpose. Their Engineer was now busily engaged in preparing the necessary plans and specifications for executing this important work; and he had reason to believe that at their next meeting they would be able to report that a contract had been entered into for carrying it out. The Royal Commission on the London Water Supply continued to hold their sittings under the able chairmanship of Lord Llandaff. The case for the Companies had not yet come before the Commission. It was impossible for him to fix a date when this would occur; but they might rely upon it that whenever the turn of the Companies came, they would do their best to show that their undertakings were in a satisfactory condition, and that they were doing their work to the best of their ability. In some respects they were in a more favourable position than the other London Water Companies, for their undeveloped district consisted of only 400 acres; while he believed that some of the other Companies had thousands of acres undeveloped. Having only 400 acres themselves, when this part of their area was built upon their district would be completed, so far as regarded water supply. They were advised that when the 400 acres were covered with houses, their maximum supply could not exceed 17½ million gallons per diem; and when he told them that the Company had the right to draw 22 million gallons per diem from the Thames, they would see that their position was one of comfort, and, in this respect, free from anxiety. They were the smallest of the London Water Companies; and they would therefore probably be called before the Royal Commission last on the list. But though they were the smallest, they were not the least important; they were second in order of date. The New River Company, as most of them were aware, was originated in the reign of James I.; and the Chelsea Company's first Act of Parliament bore date the eighth year of George I. They were able to maintain their dividend. They were paying the maximum rate of 10 per cent. per annum, together with a further dividend of 5s. per cent. on account of back-dividends; making the same rate of distribution as on the last occasion. Before concluding, he desired to refer to the devotion and ability displayed by their excellent Secretary in the performance of his duties. The Company were to be congratulated on having such a staff as they possessed. The Assistant Secretary, the Engineer, the Assistant Engineer—in fact, all the staff—conducted themselves and performed their duties to the entire satisfaction of the Board.

The Deputy-Governor (Mr. Jackson Hunt) seconded the motion.

Mr. Besley, Q.C., desired to congratulate the Governor on representing a Company which undoubtedly stood in the first place of all the Water Companies of London. He also wished to congratulate the Directors, as a shareholder, on the wise policy of increasing their storage capacity. He hoped, however, that the Board would not lose sight of the importance of not extravagantly supplying water to waste. It had been found, by the agency of a staff who went round and tested areas of supply, that about 7 or 8, or even 10 gallons a head, was wasted in the summer time by reason probably of carelessness on the part of the consumers. He had a very strong opinion that 35 gallons per head per day was the maximum amount of water that ought to be supplied in the Metropolis; and he believed that this was above the average in the Provinces. He urged them not to allow the amount of water demanded to be exaggerated by reason of waste, and not to hurry the time when such an extravagant proposal as bringing water from Wales might meet with countenance. He did not think it met with any countenance at present except from a particular place, commonly called "Spring Gardens." He thought it was not necessary for them to look further ahead than the Royal Commission did—1931; and up to that date, with fair attention, they would be able to supply all the wants of the population.

The Governor, in reply, stated that, with regard to the question of waste, the Company had had for years a large staff of inspectors, who were busily engaged in checking waste as far as possible throughout the district. When the whole of their supplies were put upon the constant system, the waste inspectors would have nothing else to attend to but the checking of waste throughout the district. The matter was therefore not lost sight of by the Directors. In fact, it was a subject which was ever uppermost in their minds. He put the motion; and it was carried.

Resolutions were afterwards passed authorizing the Directors to set apart out of the profits sufficient to pay the preference dividends which will become due on the 5th prox.; declaring the dividend recommended on the ordinary capital; re-electing the retiring Directors (Sir H. B. Poland, Q.C., Mr. G. F. Aston, and Mr. H. H. Child) and the retiring Auditor (Mr. H. P. Bodkin); and electing Mr. John Drew an Auditor to fill the vacancy caused by the election of Mr. Child as a Director.

Mr. Besley, in proposing a vote of thanks to the Governor and other Directors, expressed his conviction that they might anticipate a prosperous and successful series of years.

Mr. Bodkin seconded the motion, which was carried unanimously.

The Governor briefly acknowledged the vote, and assured them that they might rely on the Directors doing their utmost to deserve a continuance of the confidence which had been expressed in them.

THE LOCAL GOVERNMENT BOARD AND THE PROTECTION OF SOURCES OF WATER SUPPLY.

The Opposition to the Proposed General Legislation.

It will be seen by our "Parliamentary Intelligence" that, in compliance with a freely-expressed wish of the House of Commons, the President of the Local Government Board (Mr. Chaplin) withdrew last Thursday the clauses prepared by the Board for insertion in the Water Bills of the present session, with the view of securing the protection of sources of water supply. The clauses were given in the "JOURNAL" for the 31st ult. (p. 1271), and, as already pointed out, their adoption would have resulted in an important alteration of the general legislation in regard to water supply. The Bill selected for bringing the question before the House—the Higham and Hundred of Hoo Water Bill—is one of the simplest possible character (five clauses only) to amend a previous Act of the Company concerned, but conferring no additional powers; while the proposed clauses manifestly affected a variety of interests. The parties to whom those interests had been confided, considered it to be their duty to place in the hands of members a statement of their views on the subject.

It was submitted that the clauses raised very serious questions of principle affecting public policy and parliamentary procedure, inasmuch as, in the first place, they were in direct contravention of the principle acted upon every session by the House of Commons in appointing the Police and Sanitary Committee; such principle being that no amendment of the general law should be allowed by a Private Bill without previous inquiry by the Committee as to the reasons for the proposed amendment and the conditions under which it should be permitted. It was pointed out that no argument could be adduced in support of inserting the clauses in the particular Bill chosen, which would not apply with infinitely greater force to every other water undertaking in the kingdom. It was therefore submitted that the proper and regular course was by way of a Public Act to amend the Water-Works Clauses Act.

In the second place, the clauses were an attempt to override the decisions of the several Select Committees to whom the Higham and other Water Bills of the session were referred, which Committees had before them the recommendations of the Local Government Board, upon which the clauses were based, but decided not to adopt same. Lastly, they constituted a grave breach of the Standing Orders of Parliament, which would inevitably involve the several Bills affected in serious Standing Order difficulties during their future progress.

The opponents then proceeded to show that the clauses were illogical and capricious in application, inasmuch as, while they would be made to apply to one of the smallest water companies in the kingdom, supplying a sparsely populated rural district, and getting its supply from wells sunk upwards of 160 feet in the chalk, the purity of which was absolutely beyond suspicion, the large undertakings, both in the Metropolis and in the country, deriving their supply under conditions of great complexity, and where, from a variety of causes, there might be some risk of pollution, were not to be brought within the operation of the clauses until they happened to be promoting a Bill in Parliament—it might be twenty or thirty, or even more, years hence.

It was next shown that the clauses were impracticable, ineffective, vexatious, and dangerous. They were impracticable and ineffective because they did not secure that the samples of the water authorized to be taken were samples of the water as proposed to be supplied to the consumer; nor did they require any consumer taking a sample to submit it for analysis by a competent person. Then the tribunal which was to impose the penalty was not competent to deal with matters of the kind, and therefore its decisions would not inspire confidence. Furthermore, while water suppliers were to be penalized for failure to keep a supply of pure and wholesome water, which failure might arise from circumstances entirely beyond their control, no power was given to the water suppliers to prevent the pollution of the sources, when these were not under their control.

As to the vexatious and dangerous character of the clauses, it was shown that they would lead to great conflict of jurisdiction and friction between water and other authorities, while they would confer no commensurate benefit upon the consumer; they would tend to weaken the sense of responsibility in the matter now felt by the Medical Officer of Health, or the other proper qualified officer; and they would place in the power of every water consumer, with his ignorance of technical details, the opportunity to raise a scare as to the water supply of any particular place. It was pointed out that this was a danger which might become very acute in a health resort, where so delicate a matter as the impeachment of the water supply should only be possible on the trained judgment of an expert, and not upon the expression of opinion, encouraged by the proposed clauses, of an irresponsible amateur who might not inconceivably have some ulterior object in view.

In conclusion, the promoters of the Bill and the Local Authorities and Companies on whose behalf the statement was prepared, expressed their appreciation of the spirit in which the clauses had been proposed; but, on the grounds and for the reasons (among others) set forth, in the interests of the community at large, and as a matter of simple justice to the Company specially concerned, and others promoting Water Bills in the present session, it was earnestly hoped that the House would reject the motion for the insertion of the clauses.

Mansfield Corporation New Water-Works.—It was reported at the last meeting of the Mansfield Corporation that the total amount of the loans sanctioned in connection with the new water-works was £32,200. The gross amount of the tenders accepted was £32,067; and the net cost of the works was £30,639, or £1427 less than the amount of the accepted tenders. The gross cost of the works had, however, amounted to £33,443, or £1243 in excess of the loans obtained. The statement was referred to the Finance Committee, with a view to an application being made for sanction to a supplemental loan.

GAS AND WATER COMPANIES STOCK AND SHARE LIST.

Referred to on p. 1571.

Issue.	Share	When ex-Dividend.	Dividend or Dividend & Bonus.	NAME.	Closing Prices.	Rise or Fall in Wk.	Yield upon Investment.
£			p. c.	GAS COMPANIES.			£ s. d.
590,000	10	Apl. 15	10½	Alliance & Dublin 10 p. c.	23—24	−½	4 7 6
100,000	10	,,	7½	Do. 7 p. c.	16—17	..	4 8 3
300,000	100	Jan. 3	5	Australian 5 p. c. Db.	107—109	..	4 11 9
200,000	5	May 26	6	Bombay, Ltd.	⅝—6¼	..	4 16 0
40,000	5	,,	6	Do. New, £4 paid	4½—5	..	4 16 0
300,000	Stk.	Feb. 24	12	Brentford Consolidated	280—285	−10	4 4 3
240,000	,,	,,	9	Do. New	210—220	−2½	4 1 10
50,000	,,	,,	5	Do. 5 p. c. Prf.	140—145	..	3 9 0
159,375	,,	June 10	4	Do. 4 p. c. Db. Stk.	130—135*	..	2 19 3
220,000	Stk.	Mar. 30	11½	Brighton & Hove Orig.	268—273	−2	4 4 3
218,820	,,	,,	8½	Do. A. Ord. Stk.	195—200	..	4 5 0
933,500	Stk.	Feb. 24	5	Bristol, 5 p. c. max.	127—132	..	3 15 9
420,000	20	Ma . 30	11½	British	54—56	..	4 0 4
50,000	10	Mar. 11	11½	Bromley, Ord. 10 p. c.	25—27	..	4 5 2
75,000	10	,,	8½	Do. 7 p. c.	20—22	..	3 17 3
500,000	10	Apl. 29	6	Buenos Ayres (New) Ltd	9—9½	..	6 6 4
98,122	Stk.	Dec. 30	4	Do. 4 p. c. Db. Stk.	99—101	..	3 19 3
150,000	20	Mar. 11	8½	Cagliari, Ltd.	30½—31½	..	5 4 9
100,000	10	June 10	7	Cape Town & Dis., Ltd.	15—16*	..	4 7 6
50,000	50	May 3	6	Do. 6 p. c. 1st Mort.	58—60	..	5 0 0
550,000	Stk.	Apl 15	13½	Commercial Old Stock	320—325	..	4 3 1
200,750	,,	,,	10½	Do. New do.	250—255	..	4 2 4
200,750	,,	June 10	4½	Do. 4½ p. c. Db. do.	148—153*	..	2 18 10
80,000	Stk.	June 10	12	Continental Union, Ltd.	205—210*	−2	5 14 3
200,000	,,	,,	9	Do. 7 p. c. Prf.	190—195*	−5	4 12 4
51,600	Stk.	Feb. 24	14	Croydon A 10 p. c.	310—315	..	4 8 11
168,400	,,	,,	11	Do. B 7 p. c.	255—265	..	4 3 0
535,000	Stk.	Feb. 24	5½	Crystal Palace Ord. 5 p. c.	125—130	..	4 0 9
60,000	,,	,,	5	Do. 5 p. c. Prf.	142—145	..	3 9 0
486,090	10	Jan. 27	11	European, Ltd.	23¾—24½	..	4 9 9
354,060	10	,,	11	Do. £7 10s. paid	17—18	..	4 11 9
5,922,110	Stk.	Feb. 10	12½	Gaslight & Coke, A, Ord.	210—215	−3	4 6 3
100,000	,,	,,	4	Do. B, 4 p. c. max.	118—123	..	3 5 1
665,000	,,	,,	10	Do. C, D, E, 10 p. c. Prf.	302—307	..	3 5 2
30,000	,,	,,	5	Do. F, 5 p. c. Prf.	150—155	..	3 4 6
60,000	,,	,,	7½	Do. G, 7½ p. c. do.	220—225	..	3 6 8
1,300,000	,,	,,	7	Do. H, 7 p. c. max.	195—200	..	3 10 0
463,000	,,	,,	10	Do. J, 10 p. c. Prf.	300—305	..	3 5 7
476,000	,,	,,	6	Do. K, 6 p. c. Prf.	182—187	..	3 4 2
1,061,150	,,	June 10	4	Do. 4 p. c. Db. Stk.	130—133*	..	3 0 2
294,850	,,	,,	4½	Do. 4½ p. c. do.	148—153*	..	2 18 10
958,000	,,	,,	6	Do. 6 p. c. do.	198—203*	..	2 19 1
70,000	10	May 12	8	Hongkong & China, Ltd.	13½—14½	..	5 10 4
3,800,000	Stk.	,,	10	Imperial Continental	207—212	..	4 14 4
376,400	100	Feb. 1	4	Do. 4 p. c. Dbs. Red.	98—101	..	3 19 3
473,600	Stk.	Feb. 10	3½	Do. 3½ p. c. Db. Stk.	103—106	..	3 6 0
560,000	100	Apl. 1	5	Met. of Melbourne	5 p. c. Db.	110—112	..	4 9 3
					4½ p. c. Db.	107—109	..	4 2 7
250,000	100	,,	4½				

* Ex div

Issue	Share.	When ex-Dividend.	Dividend or Dividend & Bonus.	NAME.	Closing Prices.	Rise or Fall in Wk.	Yield upon Investment.
£			p. c.	GAS COMPANIES.			£ s. d.
75,000	5	Dec. 15	6	Malta & Medn., Ltd.	⅞—1	−¼	5 9 1
541,920	20	June 10	5	Monte Video, Ltd.	14—15*	..	6 13 4
617,946	Stk.	Feb. 24	9¾	Newc'tle & Gatesh'd Con.	235—240	..	4 1 3
252,355	Stk.	Jan. 3	8¾	Do. 3½ p. c. Db. Stk.	115—120	..	2 18 4
150,000	5	May 26	8	Oriental, Ltd.	7½—8	..	5 0 0
135,000	5	,,	8	Do. New, £4 10s. pd.	6½—7	..	5 2 11
15,000	5	,,	8	Do. do. 1879, £1 pd.	1½—1⅝	..	4 11 5
60,000	5	Mar. 11	7	Ottoman, Ltd.	4½—5½	..	6 13 4
500,000	100	June 1	6	People's Gas } 2nd M. of Chicago } Bd.	103—108	..	5 11 1
848,070	10	May 26	6	River Plate Ord.	⅞—⅞	..	6 6 4
250,000	Stk.	Jan. 27	4	Do. 4 p. c. Db. Stk.	98—100	..	4 0 0
250,000	10	Apl. 29	10	San Paulo, Ltd.	14½—15½	−½	6 9 0
135,000	Stk.	Mar. 30	10	Sheffield A.	245—248	..	4 0 8
209,053	,,	,,	10	Do. B.	245—248	..	4 0 8
447,427	,,	,,	10	Do. C.	245—248	..	4 0 8
5,531,250	Stk.	Feb. 24	5½	South Metrop., 4 p.c Ord.	138—143	..	3 13 5
1,460,000	,,	Jan. 13	3	Do. 3 p. c. Db. Stk.	100—103	−1	2 18 3
60,000	Stk.	Mar. 11	12	Tottenham and } A. Edmonton } B.	285—295	..	4 1 4
60,000	,,	,,	9		205—215	..	4 3 9
182,380	10	June 10	7	Tuscan, Ltd.	13—14*	..	5 0 0
149,900	10	Jan. 3	5	Do. 5 p. c. Dbs. Red.	100—103	..	4 17 1
				WATER COMPANIES.			
746,164	Stk.	Dec. 30	10½	Chelsea, Ord.	320—325	..	3 4 7
150,000	,,	,,	5	Do. 5 p. c. Prf.	172—177	..	2 16 6
160,000	,,	,,	4½	Do. 4½ p. c. Pf. Stk., 1875	150—155	..	2 18 1
175,785	,,	Mar. 30	4½	Do. 4½ p. c. 1 b. Stk.	157—162	..	2 15 7
1,720,560	Stk.	Apl. 15	8	East London, Ord.	225—230	..	3 9 7
654,740	,,	Dec. 30	4½	Do. 4½ p. c. Db. Stk.	158—162	..	2 15 7
390,000	,,	,,	3	Do. 3 p. c. Db. Stk.	104—106	..	2 16 7
700,000	50	Dec. 15	7½	G'd Junct'n, 10 p. c. max.	117—120	..	3 2 6
310,000	Stk.	Mar. 30	4	Do. 4 p. c. Db. Stk.	140—145	..	2 15 2
708,000	Stk.	Feb. 10	13	Kent	358—363	..	3 11 8
160,000	,,	,,	7	Do. New, 7 p. c. max.	218—218	..	3 4 3
1,043,800	100	Dec. 30	10	Lambeth, 10 p. c. max.	298—303	+1	3 6 0
406,200	100	,,	7½	Do. 7½ p. c. max.	228—233	..	3 4 4
350,000	Stk.	Mar. 30	4	Do. 4 p. c. Db. Stk.	140—145	..	2 15 2
500,000	100	Feb. 10	13	New River, New Shares	432—437	..	2 19 6
1,000,000	Stk.	Jan. 27	4	Do. 4 p. c. Db. Stk.	141—146	..	2 14 10
902,300	Stk.	Dec. 15	6	Southw'k & V'xhall, Ord.	165—170	+3½	3 10 7
126,500	100	,,	6	Do. do. 7½ p. c. max.	155—160	+3	3 15 0
489,200	Stk.	,,	5	Do. do. 5 p. c. Prf.	170—175	..	2 17 2
1,019,585	,,	Apl. 15	4	Do. 4 p. c. A Db. Stk.	141—144	+1	2 15 7
1,155,066	Stk.	June 10	10	West Middlesex	295—300*	..	3 6 8
200,000	,,	,,	4½	Do. 4½ p. c. Db. Stk.	162—165*	+2	2 14 7
200,000	,,	Mar. 11	3	Do. 3 p. c. Db. Stk.	104—106	..	2 16 7

* Ex div.

NOTES FROM SCOTLAND.

From Our Own Correspondent.

Saturday.

The annual accounts of the Edinburgh and Leith Gas Commission have come into my hands to-day; but the time at my disposal is so short that I feel I might not do them justice were I to write much upon them this week. I find, at a glance, however, that the sales of gas amounted to 1,557,256,300 cubic feet—an increase of 40,317,200 cubic feet during the year. The revenue amounted to £247,047, as compared with £243,330 in the previous year. The receipts from gas were £228,061, as against £222,072. From coke, tar, and ammoniacal liquor, the receipts were less. Of coal, 155,240 tons, costing £83,490, were carbonized; and of oil, for carburetted water gas—a new item—1373 tons used, costing £4262. The outlay on carbonizing materials was thus £87,752. This compares very favourably indeed with £91,272 for the 162,816 tons of coal which were carbonized in the preceding year. The balance carried to profit and loss account is £54,997, as compared with £40,570. It must not be forgotten that this is the first year of the working by the Commissioners of the small gas undertaking at Portobello, which must, considering that the price of gas there has been made uniform with that charged in Edinburgh and Leith, be carried on at a loss. When this is taken into account, there is all the more reason for congratulating the Commissioners on the excellent results they have obtained all over, and their Engineer also (Mr. W. R. Herring) on his successful pilotage of the undertaking during his first year of office. The accounts are to be laid on the table at a meeting of the Commissioners on Monday.

The Peebles controversy stands where it was last week. No more circulars have been issued by either of the parties; but both sides have taken advantage of the columns of the "Peeblesshire Advertiser" to air their views in letters to the Editor. Treasurer Williamson endeavours to show, from figures which he says he has culled from the statistics published by the North British Association of Gas Managers, that the price of gas in Peebles has been kept at a higher rate than in other towns similarly situated; and that the capital of the Peebles Company is relatively high, though I do not think he quite goes so far as to say that it is higher than the average. Now, as to the statistics of the North British Association of Gas Managers, what I say is that they are not safe for the uninitiated to found conclusions upon. For example, he instances Hawick, where the price of gas is 3s. 6½d. per 1000 cubic feet, and Galashiels, where it is 3s. 4d., as against Peebles, where a year ago it was 4s. 7d. We all know why gas is abnormally cheap in those two places; but there is another reason for this cheapness, which is that in both towns the consumption is four times what it is in Peebles. The other places mentioned, I observe, are, with one exception, sea-coast towns; and undoubtedly the sea carriage of coal makes a difference in cost which enables gas to be sold cheaper than where there is no such competition. But there is so much variance in the conditions under which gas is produced, that generalization from statistics is labour lost. As to the capital of the various undertakings, I have experience of that, because I once, in connection with a proposed transfer, accepted the return given in the statistical report of the North British Association, and afterwards found that the Company regarded their capital as nearly double what was returned. There is, undoubtedly, a great deal of looseness in the keeping of the capital accounts of many gas companies—I am referring to non-statutory companies, of course. The letter on the side of the Gas Company was written by Mr. W. Young; and it is, as all his communications have been, moderate in tone and fair in spirit, even to the extent of admitting that Treasurer Williamson has been the means of benefiting the town in many ways, and expressing the hope that a settlement might be come to out of the Law Courts. The only complaint he makes in his letter is that Mr. Williamson has unfairly taken the current year's profit as a basis for the valuation of the Company's undertaking. In illustration of his contention that the business of the Company is a progressive one, he states that the net profit in 1888 was £878; that in 1892 it had increased to £1177; that in that year the price of gas was reduced by 5d. per 1000 cubic feet, and the net profit fell to £804; but that last year the profit had risen to £1206. Taking the past ten years, the total profits amounted to £9845, or an average of £984 a year; and this fact, he considers, justifies him in estimating that the annual profit will, in future, amount to £1000. There is also published to-day a long letter by a ratepayer, who, writing on the side of the Gas Company, urges conciliation. The proposals of the members of the Corporation who have put the Town Council into the absurd attitude they have taken up, do not appear, I am happy to say, to receive the support of the community. In this fact lies ground for hoping that a settlement may yet be come to which will not be unfavourable to the Gas Company.

The great Stirling gas controversy is at an end. Originating more than two years ago in the mild form of a remit to obtain a valuation of the undertaking of the Gas Company, with a view to purchase, there was every prospect of an amicable agreement being arrived at; but after Mr. M'Gilchrist, of Dumbarton, had placed his valuation on the undertaking, there arose opposition. An attempt was made to have the valuation fixed by a limited reference to the Sheriff of the county (Mr. Lees); and this step resulted in £1500 being added to Mr. M'Gilchrist's valuation. Then arose the great whirlwind of declamation—dictated, I can only think, not so much by regard for the good of the community as by personal considerations; and the movement grew in volume and intensity, though not, I believe, in power, till it received a check in the House of Lords in March last. Since then it has been on the decline; and it finally spluttered out before a House of Commons Committee last Thursday. Now should be seen, by those who at present control the Town Council's movements, the folly of their whole procedure. They professed to be horrified at the propositions of the Gas Company, under which they said the Company could extract as much as £5344 out of the pockets of the community annually. They must have had small intelligence who put forward this view, because they well knew that the profits of the Stirling Gas Company do not amount to more than £2600 odd. The figure taken was the maximum which it was possible to attain to; but in the hands of skilled "bogey men," it was sufficient to frighten a sufficient number of the unthinking electors. When the Company's Bill came before a Select Committee of the House of Lords in

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March last, the Company offered to accept a capital of £50,000, of which £30,000 should be the original capital, bearing interest at 10 per cent.; £10,000 should be original capital, bearing interest at 5 per cent.; and the remaining £10,000 should be new capital, to be raised as required for purposes of extension. The price of gas they proposed to fix at 3s. 8d. per 1000 cubic feet, with the sliding-scale, and the illuminating power at 22 candles. This, at most, would have taken £4000 a year from the community. The House of Lords sanctioned the proposals of the Company, with the exception that they reduced the standard price to 3s. 6d. I fancy the Gas Company must have been amazed at their success. It was, indeed, a signal triumph. Prudent opponents would have accepted the defeat; but, instead, the drum was again beaten, and the fight proceeded before a House of Commons Committee. In the House of Commons, what was chiefly asked for was a suspensory clause, to give time to allow the Corporation to consider the question of purchase. It was easily brushed aside; for a Corporation who have had the subject before them, as has been the case in Stirling, since 1878, and have not been able to make up their mind, have no claim for further indulgence. The Commons Committee seemed to be going against the Corporation; and accordingly, on the morning of the third day of the inquiry, the representatives of the Corporation offered terms, which were accepted by the Company. These are that the capital is to be £40,000, of which £30,000 is to bear interest at 10 per cent., and £10,000 at 5 per cent.; and that the standard price is to be 3s. 4d. per 1000 cubic feet, and the illuminating power 25 candles. There, again, the Company have got their own terms. I have no doubt that, if the same conditions had been offered in Stirling, they would have been accepted. Under the settlement which has been arrived at, the utmost that the Company can take from the community is £3200 a year. We shall now be told that the efforts of the Corporation have resulted in a saving of £2144 a year to the town; but it will be ridiculous to say that they have saved this, or any, sum. If you have a Company who can only earn £2600 a year, given power to earn up to £3200, the success of any proposals to restrict the earnings of the Company are not apparent. But the folly is deeper rooted than this amounts to. Under Sheriff Lees' decision, the price would have been £62,697, which, at 3½ per cent.—a rate at which Stirling could easily borrow money—would have entailed an annual charge of £2194. In addition, there would have been the sinking fund of 2½ per cent.; but that is a "sinking" fund, and by its operation in a few years the annual charge would have been less than it is now, while in about thirty years the whole £62,000 would have been wiped out, and the undertaking would have been the absolute property of the community. Instead of this, what they have in prospect in Stirling is an annual drain upon them, probably amounting in a few years to £3000, to go on for all time; or, if they wish now to acquire the undertaking, they will have to meet a statutory Company and pay a price accordingly. Apart from the money which has been squandered, this is a sorry result after two years' agitation. The experience at Stirling cannot be writ too large, in the interests of those who may have to follow in the matter of municipalizing gas undertakings; for in time to come, it cannot be looked upon in any other light than that of a "fearful example" of "how not to do it."

Referring to the accounts of the Dundee Gas Department, which I noticed last week, I may say that the Treasurer had prepared a table showing the consumption of gas per head of the population during the last five years. The figures were as follows:—

	Population.	Cubic Feet of Gas Sold.	Per Head.
1894	156,247	431,882,650	2764
1895	158,719	447,911,500	2822
1896	160,163	464,216,750	2898
1897	161,620	488,688,100	3023
1898	163,090	508,871,700	3120

The population is increasing rapidly, and the Corporation will require to see that they keep pace with it. They are about to expend about £100,000 upon extensions of the gas-works; but they do not seem to be in a hurry over it. Last week a deputation from the Town Council visited Aberdeen, to see a new fire station. But when they were there, some of them had a look also at the Aberdeen Gas-Works; and at a luncheon afterwards, one of the visitors acknowledged that, in the matter of the gas-works, Dundee is twelve years behind Aberdeen. That is so; but now that the Corporation are aware of it, they may take means to remove the drawback at an early date.

Mr. Boyd S. Brown, a town councillor of Glasgow, appears to have taken the gas depositor under his arm. At a meeting of the Town Council last week, he gave notice of the following motion: "That a return be submitted by the Treasurer of the Gas Department setting forth—(1) The number of consumers in the city; (2) the number of consumers who are required to lodge a deposit in respect of, or as security for, the supplies of gas to them; (3) the amounts of such deposits; (4) the reasons for requiring the same, or the basis of so requiring; (5) the rental of the respective properties whose owners or occupiers have lodged deposits; (6) the period, if fixed, during which such deposits are to remain; (7) what interest, if any, is allowed to the depositors on the return of the amount of their deposits; and (8) the number and amounts of unclaimed deposits." I understand there was some chaff in the Council, when the motion was read over, as to why there was not a ninth head. Well, there ought to have been a ninth, and perhaps a tenth. I would have made the ninth head the number of times that the deposit was brought into requisition to meet accounts for gas; and the tenth, the number of bad debts which have been incurred (1) by new consumers from whom it was not thought necessary to ask a deposit, and (2) by old consumers, to whom their deposits had been returned. The subject is about as endless as the number of consumers themselves, because the circumstances differ in every case. As has been frequently remarked at meetings of gas managers, the cure for the deposit system is the prepayment meter; and the Convener of the Committee, when the motion comes up for discussion, may have something to say upon this point.

It is exceedingly gratifying, in the recollection of the lugubrious things which were said, at the time of the Dunfermline gas transfer, of the ability of the town to keep a prosperous gas-works going, to find that, under Mr. Pooley's management, the undertaking continues to flourish.

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The profit for the year amounted to £2973, as compared with £1742 in the preceding year, which was the first of the Commission's existence; but the first year was two weeks short of the full period, the transfer having taken place as at May 31. Mr. Pooley estimates a gross profit for the current year of £6420, and a balance of £927. He suggested to the Commission that, out of this balance, they could afford to reduce the price of gas by 2d. per 1000 cubic feet, and abolish half of the meter-rents; but the Gas Committee, in a spirit of caution, recommended that the reduction in price should be only 1d. per 1000 cubic feet, and that half the meter-rents should be abolished. This will absorb £439 of the surplus. The Commissioners unanimously approved of the recommendation. The reason why the course was not adopted of abolishing the whole of the meter-rents is that in Dunfermline a number of consumers own the meters they use; and it was thought desirable that they should receive some consideration. Mr. Pooley was highly praised by Provost Scobie for his efficient management of the works.

The Forfar Gas Corporation on Monday night succeeded in settling their coal contracts for the year. The average price, including 1420 tons of last year's contract which are undelivered, is 16s. 2½d. per ton, as against 16s. 4d. The Contractors were the same as before, with the exception of two instances, in which new Contractors had been chosen because the old ones had raised the price of their coal. Mr. Craik, the former Convener, was of opinion that, in the case of at least one of the old Contractors, they had had their coal for a considerable time, and it was a very good coking coal. Provost M'Dougall objected to interference with the selection of the Manager and the Convener. Mr. Christie expressed the fear that they might get poor gas out of the new coal. Is there any connection between this change of Contractors and the objection which was taken so forcibly to the introduction of the Fife Coal Company? Does a Convener, when he takes a fancy to a particular coal, think that it should be always purchased, in preference to all others?

In the First Division of the Court of Session to-day, two men named George Roberts, *alias* George Terry, and Duncan M'Culloch, both belonging to Glasgow, were sent to prison for one month, for breach of an interdict which had been obtained against them at the instance of the Incandescent Gas-Light Company, in connection with the sale of infringing mantles. The proceedings against these men and others have gone on since before the close of last year; and they are not yet completed, as one man has still to be dealt with for breach of interdict, and a fresh interdict has been served upon another. The operations of the infringers were conducted with great subtlety; and difficulty has been experienced in running them to earth. The practice of selling mantles which, whether an infringement or not, are objected to by the owners of the Welsbach patent, is extremely common; the sellers going about from door to door hawking them. An example, such as has been made in this instance, may put a check upon the illicit trade.

Water and Drainage Works for Callao.—The Municipality of Callao have decided to construct water and drainage works at an estimated cost of £60,000.

CURRENT SALES OF GAS PRODUCTS.

LIVERPOOL, *June* 25.

Sulphate of Ammonia.—Within the past few days, there has been considerable activity in the market, and an improvement in values; the closing quotations being £9 2s. 6d. to £9 5s. per ton f.o.b. at the ports. Consumers for the most part remain aloof. Buyers, for covering, who have hitherto been able to postpone their purchasing, have been forced by the approach of the close of the month to secure their requirements; and a fair amount of business has also been done for delivery over early months. In the forward position, Beckton has been sold at up to £9 2s. 6d. per ton, Beckton terms; and £9 5s. is now the quotation. Scotch makers are very firm; and their quotation for July-December is £9 10s. per ton f.o.b. Leith, ordinary terms.

Nitrate of Soda is rather easier on spot owing to arrivals; and 7s. 7½d. per cwt. is being accepted for fine quality.

LONDON, *June* 25.

Tar Products.—A dull market characterizes the position; and, although there is no change in quoted values, practically little or no new business is being transacted. The early close of the pitch shipping season has not affected the market, as it was speculated it might; and makers find themselves not inconvenienced with stock. Benzol is being unduly depressed by dealers. Most producers, being well sold, are not offering; and many parcels now changing hands were bought some time ago with a view to a rise. Timber picklers are very busy; and deliveries on old creosote contracts are now being taken up freely. Again, there is a disparity between the value of crude carbolic and crystals. The outlook for carbolic acid, however, is not discouraging. Anthracene is worse than dull; and no business of magnitude has been reported for some time.

The average quotations for the week are: Tar, 10s. to 14s. Pitch, 21s. to 22s. 6d., east coast; 18s. to 19s. west coast. Benzols, 90's, 10d.; 50's, 11d. Toluol, 1s. 2d. Solvent naphtha, 1s. 2d. Heavy naphtha, 1s. 1½d.; crude, 30 per cent. naphtha, 4½d. Creosote, 2½d. Heavy oils, 45s. to 50s. Carbolic acid, 60's, 2s. Naphthalene, 50s.; salts, 30s. Anthracene, "A," 4½d. to 5d.; "B," 3d. to 4d.

Sulphate of Ammonia.—A fairly steady market, with considerable shipments going on, represents the position in all quarters. To-day's value is about £9 2s. 6d., less 3¼ per cent. at all British ports; and as nitrate of soda is firm, with a tendency to higher rates, it is reasonable to hope that sulphate will not only maintain its value, but that it may (more than probably) be augmented during the summer and autumn months.

Cowes Gas-Works Purchase.—A report was presented by the Gas Committee at last Tuesday's meeting of the Cowes District Council regarding the purchase of the gas-works. It stated that the full cost had been: The award, £54,559; opposition to the first Act, £1003; cost of obtaining Purchase Act, £856; arbitration, £2468.

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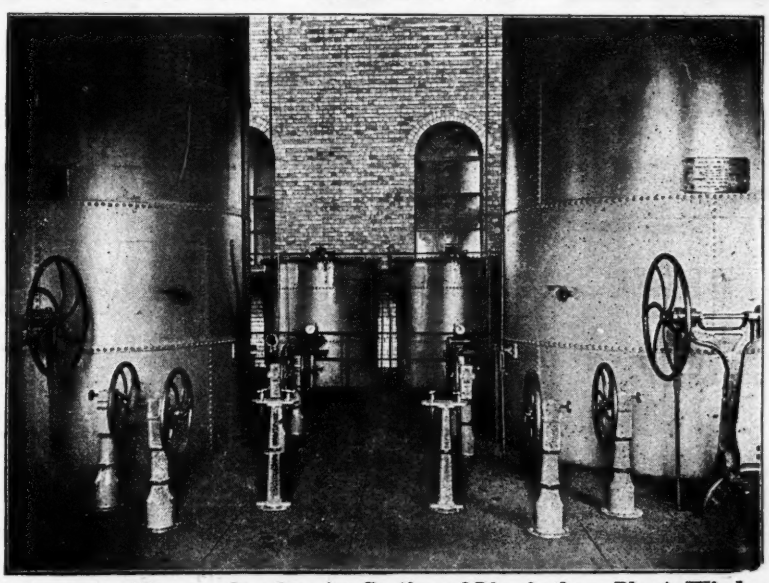

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COAL TRADE REPORTS.

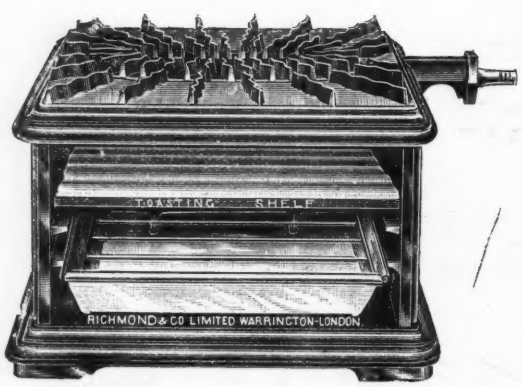
From Our Own Correspondents.

Lancashire Coal Trade.—During the past week, several of the more important gas-coal contracts in this immediate district have been closed; and generally a considerable weight of gas coal has now been settled, which affords a fairly reliable basis as to the prices likely to rule during the present season. As previously reported, some business has been put through at practically the same prices as those which were taken last year; but these would seem to be under exceptional circumstances as to the prices which were then obtained, or in all probability include some arrangement with regard to prices in the event of an advance of wages being conceded to the miners. It may be added that a sort of sliding-scale arrangement, representing an advance of 3d. per ton on inferior sorts of fuel up to 5d. per ton on better qualities of coal for every 5 per cent. advance that may be conceded to the miners in wages, is being brought forward in a good many cases, in place of putting on any present definite advance. The success of such a plan depends, of course, entirely on the basis price at which it starts; and if this is sufficiently low, no doubt buyers would be willing to enter into contracts on these terms. But a similar proposal which was put forward some five or six years ago did not meet with very much favour in the trade generally. With regard to contracts on which advances over last year's rates have been obtained, these confirm pretty much what has been previously reported, and represent something like 6d. per ton upon last season's prices. So far as anything like definite contract rates are obtainable, on a good deal of business that has been settled recently, they may be taken at about 7s. to 7s. 3d. per ton at the pit for lower qualities of gas coal—such as Wigan four-feet—and about 7s. 9d. for good screened Wigan Arley gas coal. It is anticipated that these will represent about the basis prices on which contracts of any weight that have yet to be placed will in all probability be settled. On a few small contracts, about 3d. per ton above these figures has likely been secured. Taking the general upward move in the gas coal contract prices, it can scarcely, perhaps, be said to represent a uniform advance of 6d. per ton, but rather a levelling of prices to practically one basis—the precise amount of the advance being, of course, regulated by the price which in each particular instance was obtained last year, so that it may vary from 3d. to 6d. per ton in the Lancashire district, while some of the Yorkshire contracts have been placed at advances of 3d. to 4d. per ton. The important locomotive fuel contracts, which have been held in abeyance for the past month, owing to the leading Lancashire colliery owners having firmly held out for an advance of 9d. per ton over last year's excessively low figures, have to a large extent been practically closed during the past week. The London and North-Western Railway Company have placed contracts for ordinary locomotive fuel on the basis of 6s. 6d. per ton at the pit mouth, which is 9d. per ton above the prices at which similar contracts were arranged last year. The Company have, however, considerably reduced the quantities that have been placed with some of the collieries which have been holding out for the advanced rates; and a large number of the contracts have been distributed among other concerns, from whom, it is possible, special prices may in some cases have been obtained. The Lancashire and Yorkshire Railway Company have placed contracts for the better qualities of locomotive fuel on the basis of 7s. per ton at the pit, which is about 6d. per ton over last year's prices. With regard to contracts for ordinary classes of fuel, colliery proprietors generally are holding out for 6d. to 9d. a ton on house-fire coals, about 6d. on steam and forge qualities, and from 3d. to 5d. on engine fuel, over the prices that were accepted for contracts this time last year. As to current business generally, a very steady position is maintained all through. House-fire coals, though in only moderate request, and here and there accumulating in stock, are maintaining the list rates of 10s. to 10s. 6d. per ton for the best Wigan Arley, 8s. 6d. to 9s. for Pemberton four-feet and seconds Arley, and 7s. 6d. for common coals. Steam and forge coals, and likewise engine fuel, are very firm at the prices which have been ruling recently. At the pit these average 6s. 6d. to 7s. per ton for steam coals; and 3s. 6d. for common, 3s. 9d. to 4s. 3d. for medium, and 4s. 6d. to 4s. 9d. for better sorts of engine fuel. For shipment there is also a continued active inquiry, with ordinary steam coal fetching from 8s. 6d. to 9s. per ton, delivered at the Garston Docks or the High Level, Liverpool.

Northern Coal Trade.—The coal trade in this district has been interrupted by local holidays. Prices have thus been higher, but are now returning to their normal level. Best Northumbrian steam coals are quoted at 13s. per ton f.o.b.; second-class steam coals are about 12s.; and steam smalls, 5s. to 5s. 6d. In the gas coal trade, the fixing of the large contracts previously stated has helped to determine prices; and now as high as 8s. 6d. per ton f.o.b., is quoted for occasional cargoes—even higher prices being named for the best Durham qualities. There are other local contracts for gas coals in the market; and it seems probable that in all cases there will be an appreciable advance in the cost of the coals—an advance that is partly due to the state of the market, and partly to the effect of the Compensation Act, which adds to the cost of production. Gas coke shows no change, except that the partial idleness of some factories this week has lessened the local use of this fuel.

Scotch Coal Trade.—Trade has improved to the extent that, on account of the non-settlement of the Welsh dispute and the near approach of the miners' holidays, there has been a disposition to lay in stocks. Nearly all the coal to be got during the next few weeks has been contracted for, and at better prices. The quotations are: Main, 8s. 6d. per ton f.o.b. Glasgow; ell, 9s. 3d. to 9s. 6d.; and splint, 9s. The shipments for the week were very large, amounting to 236,843 tons—an increase of 34,984 tons over the preceding week, and of 90,634 tons over the corresponding week of last year. The greater part of the increase was in the Forth and Fife districts; the Baltic trade being now in full swing. For the year to date, the total shipments have been 4,060,528 tons—an increase over the same period of last year of 672,061 tons.

Johannesburg Water-Works Company, Limited.—At the recent annual general meeting of this Company, the Chairman (Mr. C. Marx), in moving the adoption of the report and accounts, said the revenue from all sources for the year ended June 30, 1897, amounted to a total of £100,328, as compared with £78,328 for the previous year.



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New Joint-Stock Companies.—The Crowborough Gas Company, Limited, has been registered, with a capital of £25,000, in £1 shares, to enter into an agreement with R. S. Mayne, and to acquire, and carry on the undertaking of the Provincial Gas-Works (Crowborough), Limited, registered in 1897, as carried on in the districts of Crowborough and Rotherfield, in Sussex. The Leakless Gas-Joint, Limited, is the title of a company registered with a capital of £5000, in 4750 shares of £1 and 5000 founders' shares of 1s., to "acquire, own, and work certain patents and rights." The Birmingham Tube-Bending Company, Limited, with a capital of £1500, in £1 shares, will acquire the business carried on by Mr. W. Taylor as the Birmingham Tube-Bending Company.

A New Reservoir for Bangor.—In connection with the Bangor Corporation Water-Works, a new reservoir at Twrgwyn was inaugurated last Tuesday by the Mayor (Mr. Hugh Hughes). His Worship having declared the reservoir open, Alderman Dr. R. Langford Jones, the Chairman of the Water Committee, stated that the new reservoir had been constructed entirely by the Borough Surveyor, Mr. John Gill. The dimensions were: Inside, length 137 feet; width, 60 feet; depth, 13 feet; area, 8224 feet; capacity, 530,000 gallons; total cost, £1150. Mr. Gill had constructed the works at a saving of something like £120 on the lowest estimate sent in. The total water storage at present available for the city, with the addition of the new reservoir, amounted to 1,077,000 gallons. The supply was now sufficient to give every inhabitant 40 gallons per day of pure water.

Leamington Water Supply.—The Borough Accountant of Leamington (Mr. W. Bateson) has submitted to the Chairman and members of the Water and Sewage Committee a report upon the water-works for the financial year ended the 31st of March last. It shows that the income for the year was £5759; and the expenditure, £5391—leaving a surplus of £368 to be set aside as a reserve fund for future contingencies. This is the first time that a surplus appears on the water-works fund, and is accounted for by the increased water charges which came into operation at the commencement of the financial year under review. The total capital expenditure up to March 31 last was £48,696. To meet this, £45,960 has been raised on loan, £261 8s. contributed by revenue, and £2474 17s. carried forward. Of the total amount borrowed, £25,336 11s. 7d. has been repaid, or provision has been made for its redemption; leaving £20,623 8s. 5d. still owing.

Blaenavon District Council and the Water Supply.—A Local Government Board inquiry in reference to the application of the Blaenavon District Council to borrow £17,250 for the purpose of taking over the existing water arrangements of the local Gas and Water Company was held last Friday week, by Mr. W. O. Mead-King. Mr. A. E. Bowen, representing the District Council, said the present water supply was partly contributed by the Company, and partly by the Blaenavon Iron Company; the number of houses served being 7315. The actual capacities of the existing reservoirs were: No. 1, 672,350 gallons; No. 2, 1,102,790 gallons; No. 3, 2,015,670 gallons—giving an average consumption per head of 13½ gallons. The new scheme included the making of an additional reservoir on the mountain side; and land had been promised for the purpose for £5 per annum, and £10 per annum for the service from two springs. The Council asked for £17,250, computed as follows: The arbitration award, £10,250; costs of award, £2000; sum already spent in completing existing water-works since 1893, £1550; costs of present improvement scheme, £3187, which included the enlargement of No. 1 reservoir to hold a maximum of 1 million gallons. After hearing confirmatory evidence, the Inspector visited the water supply works.

Sales of Stocks and Shares.—At the Mart, Tokenhouse Yard, E.C., on Monday last week, Mr. Alfred Richards sold by auction, by order of the Directors, £7500 of "A" ordinary stock of the Brighton and Hove Gas Company, carrying 8½ per cent. dividend. The total amount realized was £14,363 10s.; being an average of £191 10s. 3d. per cent., and returning £4 8s. 9d. per cent. on the investment. On the same day, Mr. Richards, in accordance with instructions received from the Directors, offered £3000 of additional 7 per cent. stock of the Colney Hatch Gas Company. It realized £4768; being an average of £158 18s. 8d. per cent., and returning £4 8s. 1d. per cent. on the investment. At Pontefract last Wednesday, a number of shares in the local Gas Company were sold as follows: 78 ordinary 10 per cent. £10 fully-paid shares, at £27 and £27 2s. 6d. each; 19 new ordinary 7 per cent. £10 fully-paid shares, at £17 15s. to £18 5s.; 39 new ordinary 7 per cent. £10 shares (£2 paid), at £4 10s. to £4 16s. At Crediton, £100 stock in the Gas Company (paying 7½ per cent.) changed hands a few days since at £143; and £104 10s. of similar stock secured a purchaser at £171. At Hull, on Wednesday, two fully-paid £20 shares in the British Gaslight Company realized £54 each; and fifteen £15 shares in the Hessle Gas Company changed ownership at £32 apiece.

A Concert in a Gasholder Tank.—On the occasion of the anniversary of the Queen's Birthday, the annual entertainment instituted by the Manager of the South African Lighting Association (Mr. W. Arnott) took place in a novel and unique concert-room—viz., the steel tank for the new holder which is being erected at the gas-works at Port Elizabeth. It was gaily decorated for the purpose. Chairs were provided for between 200 and 300 persons; and they were all occupied. Before the concert, Mr. Arnott explained that the tank would contain the largest gasholder in South Africa—one of 200,000 cubic feet capacity—and would hold 1,315,480 gallons, or 5872 tons, of water. It was 74 feet in diameter and 18 feet deep. In the gasholder and tank there were 102,400 rivets and bolts. The Contractors were Messrs. S. Cutler and Sons, of Millwall; and the work was being carried out under the superintendence of their foreman, Mr. D. Jones. Referring to the position of the undertaking, Mr. Arnott said the public might judge, from the amount of money the Company were spending in renewing and remodelling their works, how little they feared the competition of the electric light. Cape Town was cited as an example of what the cost of electric light was as compared with gas, and what a failure the system of electric lighting there was—time after time the whole town being put into darkness. The Gas Company, with the incandescent burner, could compete, light for light, at one-sixth the cost of electricity. At the present time, the electric light was a luxury which had to be paid for.

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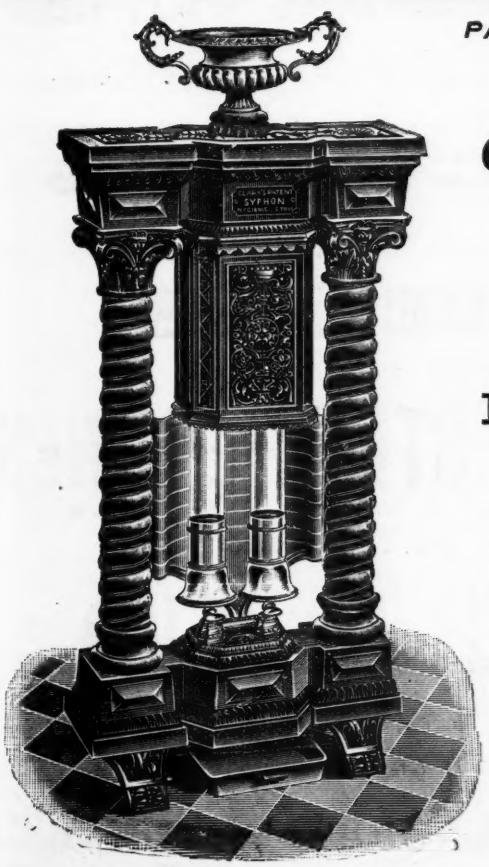

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Improvements at the Tunbridge Wells Water-Works.—The Tunbridge Wells Town Council have adopted a recommendation of the Water Committee to apply for sanction to the borrowing of £24,000, in order to filter the whole of the water which is supplied to the borough from Pembury, at a cost of £16,000; to rebuild the boiler house, and provide two new boilers at a cost of £2000; and to add two additional bore-holes and pumping machinery at Pembury, at a cost of £6000.

Coventry Corporation Water Supply.—At the meeting of the Coventry City Council last Tuesday, Alderman Read submitted the annual report of the Water Committee, from which it appeared that the rental had been the largest in the history of the undertaking—amounting to £10,545, against £9746 in the preceding year. On the other hand, the expenses had been normal, except in the item of repairs. This had been swollen by the expenditure on the thorough overhauling and repair of No. 2 engine at Spon End, which had been in progress during the year. About £900 had been paid on this account; leaving £1100 to be paid during the current year. The balance of revenue over working expenses was £4883, to which must be added interest allowed by the Bank, £81—making a total of £4964. Of this, interest on loans absorbed £1153, and the annual payment to the stock redemption fund, £461—leaving a balance of £3283. There was a balance in the Treasurer's hands, arising from the accumulated profits of former years, amounting to £2443; and the Committee were of opinion that, looking at the position and prospects of the undertaking, the Council would be justified in making an appropriation out of the profits of the present year in aid of the rates. They accordingly recommended that £3000 be so appropriated, and be paid over to the borough rate account in aid of the next two borough rates, in equal moieties. The report was adopted.

Messrs. John Wright and Co., Limited, will shortly be moving their London show-rooms from 105, Cheapside, to more commodious premises at Nos. 19 and 21, Queen Victoria Street, E.C.

The Haworth Urban District Council have placed with Messrs. Newton, Chambers, and Co., Limited, a contract for a new gasholder to be erected to the design and specification of Mr. Robert Porter, of Elland.

Mr. A. W. Crowther, of Huddersfield, has obtained the contract for resetting the inclined retorts and rebuilding the regenerator flues for the Rochdale Corporation, for which tenders were invited in the "JOURNAL" for the 7th inst.

Mr. Alfred Richards will to-morrow conduct, by order of the Directors, an important sale of 5 per cent. perpetual debenture stock of the Crystal Palace District Gas Company. The amount to be offered is £20,000; and it is issued under the provisions of the Company's Act of 1893.

Owing to the expiration of a lease, Mr. Percy Griffith, Assoc.M.Inst.C.E., &c., of No. 55, Parliament Street, S.W., has been compelled to take new offices, which he has secured in the adjoining building (No. 54). As, however, they will not be ready for occupation until Michaelmas, he has arranged for temporary offices at No. 55, Victoria Street, S.W.

Exhibitions of gas appliances have lately been held by the following firms: The Davis Gas-Stove Company, Limited, at Dorchester, with lectures by Mrs. Hunter. Messrs. Fletcher, Russell, and Co., at Belvedere (Kent), with lectures by Mrs. Hunter; and at Bradford, with lectures by Mrs. H. M. Young. Messrs. W. Parkinson and Co., at Perry Bar (Birmingham), with lectures by Miss R. Brown; and at Shifnal, with lectures by Miss E. Sanderson.

Messrs. R. Dempster and Sons, Limited, have issued a new pamphlet devoted mainly to the erection and equipment of retort-houses. The firm are sole agents for Chester's regenerative system; and the construction of a setting of eight retorts on this method is shown by seven views. These are followed by others illustrating a contract carried out for the Grantham Gas Company, according to Mr. Shadbolt's designs. The remaining diagrams show settings of retorts on the inclined and generator systems, coal-handling plant, coke-barrows, &c. The pamphlet is well got up.

NOTICE TO ADVERTISERS.—COPY FOR ADVERTISEMENTS for the "JOURNAL" should be received at the Office *not later* than TWELVE O'CLOCK NOON ON MONDAY, to ensure insertion in the following day's issue.

Orders for Alterations in, or Stoppages of, PERMANENT ADVERTISEMENTS should be received not later than the FIRST POST on SATURDAY.

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[For Illustrated Advertisement, see p. 1605.]

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(Late Essex Street Works, Victoria Embankment, London),

BROOKE STREET WORKS, HOLBORN, LONDON, E.C.

TUBES for Gas, Steam, and Water (all Sizes) Welded or Riveted. TANKS, HYDRAULIC MAINS, RETORT-LIDS, &c.
JOHN SPENCER, Globe Tube Works, WEDNESBURY; and 14, Great St. Thomas Apostle, LONDON.

HUTCHINSON BROTHERS, Gas Engineers, &c., Falcon Works, Barnsley, Makers of Wet and Dry Gas-Meters, Brass-Work, and general Gas Apparatus, Lead Saturators, Tanks, &c., Tools, and Gas-Works Sundries. (See p. 1519, this week's issue.)
Telegrams: "HUTCHINSON BROS., BARNSLEY."

AMMONIACAL LIQUOR wanted.
BROTHERTON AND CO., Ammonia Distillers.
Works: BIRMINGHAM, LEEDS and WAKEFIELD.

PATENTS FOR INVENTIONS.

J. C. CHAPMAN, M.I.M.E., and Fel. Chartered Inst. Patent Agents. ADVICE ON ALL MATTERS CONNECTED WITH ABOVE.
Information and Handbook on application.
70, CHANCERY LANE, LONDON, W.C.

WATER-GAS PLANT.

ENGINEERS contemplating the above are invited to communicate with the Advertiser, who is prepared to give every assistance in designing Plant of any capacity.
J. L. FEATHERSTONE, 30, Amesbury Avenue, STREATHAM HILL.

GAS TAR wanted.
BROTHERTON AND CO., Tar Distillers.
Works: BIRMINGHAM, LEEDS, and WAKEFIELD.

NEW GAS PLANT CEMENT.

JOHN E. WILLIAMS AND CO.,
VICTORIA PAINT WORKS,
MANCHESTER.
For all Joints in connection with Oil-Gas Plant and Sulphate Plant.
For all Gas Joints.
For all Tar Joints.
For all Ammonia Joints.

IMPORTANT.

OLD Retorts made equal to new by repairing them with CROWTHER'S PATENT STICKFAST FIRE CEMENT. Unequalled for Repairing Inclines. Can be used in Hot or Cold Retorts; and "A1." for Mouthpiece Joints. Satisfaction Guaranteed.
CROWTHER, Practical Retort Setter, Manor Street, HUDDERSFIELD.

ENRICH YOUR GAS
WITH
CHEAP BENZOL.

AT to-day's Price of Benzol, Illuminating POWER cost less than a HALFPENNY PER CANDLE.
Apply to SADLER AND CO., MIDDLESBROUGH.

CANNEL, COAL, ETC.

JOHN ROMANS & SON, EDINBURGH, Gas Engineers, supply all the most approved SCOTTISH CANNELS; also FIRE-CLAY GOODS, CAST-IRON PIPES, and other APPARATUS for GAS and WATER WORKS.
Prices, &c., will be forwarded on application to No. 80, ST. ANDREW SQUARE, EDINBURGH, } SCOTLAND.
NEWTON GRANGE, NEWBATTLE, DALKEITH, }

HYDRATED OXIDE OF IRON.

PREPARED from pure Iron.
Two or three times as rich as Bog Ore.
Strong action on Sulphuretted Hydrogen.
To be used alone, but will increase activity of other Oxides.
Less than half the price of Bog Ore.
Can be lent on hire.
Write for tabulated results.
READ HOLLIDAY AND SONS, LIMITED, HUDDERSFIELD.

GAS PURIFICATION BY HYDRATED OXIDE.

THE CHEAPEST OXIDE ON THE MARKET.

THIS Material is of full strength and exceptional activity, and is giving great satisfaction in those Gas-Works using the same.
Enquiries invited by T. B. JONES & Co., Gas-Works, Dronfield, near SHEFFIELD.

HEATING WITH GAS UNDER PRESSURE.

SPECIFICATION of Patent No. 12,744, dated 1895, are again obtainable.

SITUATION wanted by Advertiser, with 5½ Years' Experience, as CLERK in Gas Office or COLLECTOR of ACCOUNTS. Accustomed to Prepayment Meter System. Highest References. Age 23.
Address No. 3079, care of Mr. King, 11, Bolt Court, FLEET STREET, E.C.

WANTED, by a steady Man, a Situation as STOKER. Twelve Years' Experience with Regenerative, Generative, and other Settings; also accustomed to Engines, Boilers, Exhausters (both Pump and Rotary). Age 30. Total Abstainer. Willing to make himself useful. Good References.
Address 18, Railway Terrace, ABERYSTWYTH.

SITUATION wanted by a Young Man (age 22) as IMPROVER. Three years' experience in Service Laying, Fixing Meters, and general Work of a Gas-Works.
Apply to J. CLARK, 26, Fordington Hill, DORCHESTER.

WANTED, a single Man (Abstainer preferred), for small Private Gas-Works and general House Work.
Apply to L., Stoke Court, Stoke Poges, BUCKS.

WANTED, an Experienced Main and SERVICE LAYER. One accustomed to the erection of Gas-Works Plant preferred. Permanent engagement to reliable Man.
State Wages and References to No. 3086, care of Mr. King, 11, Bolt Court, FLEET STREET, E.C.

WANTED, a young Man as under STOKER, and to make himself generally useful in small Gas-Works. Must be used to Shovel Charging. A good Character indispensable.
Address MANAGER, Gas-Works, Seaford, SUSSEX.

CLERK OF WORKS.

THE City of Norwich Water-Works Company require the services of a competent CLERK OF WORKS. Must be able to set out Work correctly, take Levels, thoroughly understand Brickwork, the making of Clay Puddle and Concrete, and all details of Office Work.
Applicants must state Age, and last or present Employment, and enclose three Certificates of Capability, Honesty, and strict Sobriety.
Address JOHN AYRIS, M.Inst.C.E., Surrey Street, NORWICH.

SHEFFIELD UNITED GASLIGHT COMPANY.

WORKS SUPERINTENDENT.

WANTED, by the Directors of this Company, an experienced and competent Man to act as SUPERINTENDENT at their Effingham Street Gas-Works. (The position is vacant owing to the present Superintendent having been promoted.) He will be required to reside on the Works, with House, Coal, and Gas free.
The Maximum make of Gas at this Station is about 3½ million cubic feet per day.
Applications (marked "Superintendent"), stating Age, previous Engagements, and Salary required, to be made, by letter only, addressed to Sir Fredk. T. Mappin, Bart., M.P., Chairman of the Company, Gas Offices, Sheffield, not later than Friday, July 8, 1898. Testimonials not to be sent till asked for.
HANBURY THOMAS,
General Manager and Secretary.
Commercial Street, Sheffield,
June 15, 1898.

GAS CARBON Wanted, not less than 4-Ton Loads.
Apply to the BRIMINGTON CARBON COMPANY, Sowerby Bridge, YORKS.

WANTED, Carbon in 4 Ton Lots, or more.
State Price, f.o.r. at nearest Station, to No. 3031, care of Mr. King, 11, Bolt Court, FLEET STREET, E.C.

SULPHATE OF AMMONIA.

WANTED, a small Apparatus of the column make, to produce about 3 tons per week.
Address, with full Particulars, No. 3085, care of Mr. King, 11, Bolt Court, FLEET STREET, E.C.

FOR SALE—A Gentleman's small Gas PLANT (having put on Electric Light). Capacity of Holder 1200 feet, Purifier, Hydraulics, and 100-Light Meter, all complete A Bargain.
Apply to the RELIANCE IRON-WORKS, Farnham, SURREY.

FOR SALE, Cheap—The undermentioned GAS PLANT:—
2 PURIFIERS, 5 ft. square by 4 ft. deep.
1 PURIFIER, 5 ft. square by 2 ft. 9 in. deep.
CONDENSER, 4 inches diameter, Vertical Pipes.
EXHAUSTER (Gwynne's), 20,000 c. f. per hour.
Apply to SAML. WHILE AND SONS, 60, QUEEN VICTORIA STREET, E.C.

GAS PLANT for Sale—I can always offer NEW and SECOND-HAND GAS APPARATUS, including Retorts and Fittings, Condensers, Exhausters, Scrubbers, Washers, Purifiers, Gasholders, Tanks, Valves, Connections, &c. Also a few COMPLETE WORKS. **Compare Prices and Particulars before ordering elsewhere.**
J. F. BLAKELEY, Gas Engineer, Ravensthorpe, YORKS.

APPARATUS, SECOND-HAND, FOR SALE.

D. M. NELSON & CO., Gas Engineers, Glasgow, have a large variety to offer, embracing—
RETORT MOUTHPIECES (120), Ascension and Bridge Pipes, 5 and 6 inches.
HYDRAULIC MAINS, Steel Plate, 200 ft. by 20 in. by 18 in.
CONDENSERS, Pipe and Battery Forms.
SCRUBBER-WASHERS, Vertical and Horizontal.
EXHAUSTERS, Beale's Patent Rotary.
PURIFIERS, single and in sets, 6 ft. to 12 ft. square.
STATION METERS, 2000 to 10,000 cubic feet capacity.
VALVES, Dry and Hydraulic change.
VALVES, Four-way; also S.S. and R.P. ordinary.
TANK AND FLOORING PLATES, Malleable Iron and Cast.
Correspondence invited.

SPENT OXIDE wanted.
BROTHERTON AND CO., Chemical Manufacturers.
Works: BIRMINGHAM, LEEDS, and WAKEFIELD.

FOR SALE—The complete Gas-Works PLANT of a WOOLLEN MANUFACTORY, capable of supplying 10,000 cubic feet of Gas per diem Erected within the last Twenty Years.
Particulars from the UPTON LOVELL MANUFACTURING COMPANY, TROWBRIDGE.

EAST RETFORD CORPORATION.

THE Gas Committee are open to receive TENDERS for the purchase of their surplus TAR and AMMONIACAL LIQUOR for One Year ending June 30, 1899.
Further Particulars may be obtained on application to the undersigned.
J. B. FENWICK,
Engineer and Manager.
June 17, 1898.

EAST RETFORD CORPORATION.

THE Gas Committee of the above Corporation are open to receive TENDERS for the supply of 4000 Tons of best GAS COAL or NUTS during the Year ending June 30, 1899.
Tenders to be sent in to the undersigned, endorsed "Tender for Gas Coal," on or before July 1, 1898.
Forms of Tender not supplied.
J. B. FENWICK,
Engineer and Manager.
June 17, 1898.

BOROUGH OF BEVERLEY.

TENDERS FOR COAL.

THE Gas Committee are desirous to receive TENDERS for the supply of COAL for a period of Twelve Months from the 1st of October next, to be delivered as from time to time directed by, and at the expense of, the Contractors, f.o.b. at Keadby, or at the Pits, or at the Railway Station, Beverley, according to the Terms of Contract.
The Coal to be of the best kind, well screened, free from Sulphur, Bats, Bind, Refuse, and Dirt, and to be weighed (21 cwt. to the ton) upon the Corporation Machine.
Payments will be made monthly so long as the Contract shall be duly fulfilled.
The Corporation do not bind themselves to accept the lowest or any Tender.
Further Information may be obtained of the Gas Manager, Mr. James Gibson, at the Gas-Works, Beverley; and Tenders, endorsed "Tender for Coal," must be delivered at my Office not later than Wednesday, the 29th inst.
By order,
J. WILLIS MILLS,
Town Clerk.
Guildhall, Beverley,
June 14, 1898.

BRIDGNORTH CORPORATION GAS-WORKS.

TO COLLIERY PROPRIETORS AND OTHERS.

THE Gas Committee are prepared to receive sealed TENDERS for the supply of GAS COAL, including carriage to the Bridgnorth Railway Station, for One Year from, or soon after, the end of July next.
Evidence as to the quality of the Coal must accompany each Tender.
Quantity required: About 2200 Tons in proportionate deliveries as directed—say, 70 per cent. during Winter Months, and 30 per cent. during Summer Months.
Sealed and marked Tenders must be sent to the undersigned not later than Saturday, the 9th of July.
The Committee reserve to themselves the right to divide the quantity into two or more Contracts, and do not bind themselves to accept the lowest or any Tender.
By order,
J. H. COOKSEY,
Town Clerk, Secretary.
Bridgnorth, June 24, 1898.

CITY OF NOTTINGHAM.
(WATER DEPARTMENT.)

TENDERS FOR THE SUPPLY OF VALVES AND HYDRANTS, PIPES, LEAD, COAL, TAPS, AND FITTINGS.

THE Water Committee of the Corporation are prepared to receive TENDERS from competent Ironfounders, Brassfounders, Valve Manufacturers, Lead Merchants, and Colliery Proprietors and Coal Merchants for the supply of the undermentioned goods for the ensuing Year:—
1. CAST-IRON DOUBLE-FACED SLUICE-VALVES and HYDRANTS.
2. CAST-IRON MAIN PIPES.
CAST-IRON SPECIAL PIPES.
3. LEAD PIPING.
LEAD INGOTS.
4. GUN-METAL TAPS & FERRULE FITTINGS.
5. STEAM COAL and OTHER FUEL.
Specifications and Drawings, together with Samples, Weights, &c., may be seen and other Information obtained at the Office of the Water Manager, Mr. Stephen Moore, St. Peter's Church Side; and Forms of Tender may be obtained at that Office on payment of One Guinea, which Sum will be returned on receipt of a *bond-fide* Tender.
Tenders, endorsed "Tender for Valves," "Tender for Pipes," "Tender for Lead," "Tender for Taps," or "Tender for Coal," to be delivered to me at the Guildhall, Nottingham, on or before the 2nd day of July next.
The Committee do not bind themselves to accept the lowest or any Tender.
By order of the Water Committee,
SAMUEL G. JOHNSON,
Town Clerk,
Guildhall Nottingham
June 15, 18

SOUTHPORT CORPORATION GAS DEPARTMENT.

THE Gas Committee invite Tenders for the supply of GAS-METERS—Wet and Dry—for a period of Twelve Months from July 1 next.

Tenders, endorsed "Meters," to be in the hands of the Town Clerk, Town Hall, Southport, not later than Noon, on Tuesday, July 12 next.

JOHN BOOTH,
Gas Engineer.

RADCLIFFE AND PILKINGTON GAS COMPANY.

TENDERS FOR COAL AND CANNEL.

THE Directors of the Radcliffe and Pilkington Gas Company invite TENDERS for about 10,000 Tons of GAS COAL and CANNEL.

Particulars may be obtained from the undersigned, to whom Tenders, properly endorsed, must be delivered on or before Friday, the 1st of July.

JAMES BRADDOCK,
Manager and Secretary.

Gas Offices, Radcliffe,
June 16, 1898.

CORPORATION OF MANCHESTER.

TENDERS FOR COAL AND CANNEL.

THE Gas Committee are prepared to receive on or before Thursday, the 14th of July next, OFFERS of high class CANNELS and COALS suitable for Gas Making, for delivery at their Gaythorn, Rochdale Road, and Bradford Road Works, during a period of One, Two, or Three Years, commencing the 1st of November, 1898.

Particulars and printed Forms of Tender may be obtained on application (in writing only) to Mr. Charles Nickson, Superintendent, Gas Department, Town Hall, Manchester.

By order of the Gas Committee,
WM. HENRY TALBOT,
Town Clerk.

Town Hall, Manchester,
June 24, 1898.

HINCKLEY URBAN DISTRICT COUNCIL.

(GAS DEPARTMENT.)

THE above Council invite Tenders as follows:—

COAL—For the supply of 5,000 Tons of COAL during the Year ending June 30, 1899.

LIME—For the supply of about 200 Tons of LIME for Purification purposes during the Year ending June 30, 1899.

TAR—For the purchase of the Surplus TAR produced at their Gas-Works during the Year ending June 30, 1899.

Forms of Tender and further Particulars may be obtained on application to the Engineer and Manager, Mr. Fred. Lee.

Sealed and endorsed Tenders to be sent to the undersigned not later than Monday, the 11th day of July, 1898.

The Council do not bind themselves to accept the owest or any Tender.

By order,
J. W. PRESTON,
Clerk.

Hinckley, June 24, 1898.

GUILDFORD GASLIGHT AND COKE COMPANY.

MECHANICAL WASHER-SCRUBBER.

THE Directors of the above Company invite separate TENDERS for the Supply, Delivery, and Erection on their Works of a MECHANICAL WASHER-SCRUBBER, guaranteed to be capable of dealing with 1,000,000 cubic feet of foul Gas per 24 hours, or for similar Washer-Scrubber for 1,500,000 cubic feet.

Tenders to include HORIZONTAL ENGINE, 18-inch INLET and OUTLET and BYE-PASS VALVES and CONNECTIONS.

All to be fixed complete on Foundations provided by the Company to Contractor's Drawings.

Any further Particulars can be obtained on application to the Manager at the Works.

Tenders, endorsed "Tender for Washer-Scrubber," to be sent to David Williamson, Esq., J.P., Chairman of the Gas Company, on or before July 8, 1898.

By order,
WILLIAM TITLEY,
Secretary.

Gas Offices, Guildford,
June 18, 1898.

GLOUCESTER GASLIGHT COMPANY.

TENDERS FOR GAS COAL.

THE Directors of the above Company invite TENDERS for the supply of about 25,000 Tons of GAS COAL for One Year from the 1st day of July next, in such monthly quantities as may be required by the Company.

Tenders to state the price delivered at the Midland Railway Wharf, High Orchard, or the Great Western Railway Wharf, Llanthony, Gloucester; or if sent (as preferred) by Water, the price f.o.b., and also the price delivered at the Gas Company's Wharf on the Gloucester and Berkeley Canal.

Further Particulars and Forms of Tender may be obtained of the Company's Engineer, Mr. R. Morland.

Sealed Tenders, endorsed "Tender for Coal," specifying the description and quality of the Coal, to be addressed to the Chairman, Gas Offices, Eastgate Street, Gloucester, and delivered not later than the 1st day of July next.

The Directors reserve to themselves the right to accept the whole or any portion of any quantity offered, and do not bind themselves to accept the lowest or any Tender.

By order,
WILLIAM E. VINSON,
Secretary.

Gas Offices, Gloucester,
June 2, 1898.

TENDERS FOR COAL.

THE Directors of the Holyhead and North Wales Gas and Water Corporation, Limited, are prepared to receive TENDERS for the supply and delivery of COALS to their various Works for the ensuing Year.

Full Particulars and Forms of Tender may be had on application to the undersigned, to whom sealed Tenders, endorsed "Tender for Coal," must be sent not later than Twelve noon, Monday, July 11, 1898.

GEORGE E. SAVILLE,
Engineer and General Manager.

Conway Road, Penmaenmawr,
June 24, 1898.

RAMSBOTTOM GAS COMPANY.

THE Directors of the above Company are open to receive TENDERS for the purchase of their surplus TAR and AMMONIACAL LIQUOR, free on Rail, in Purchaser's Tanks, for One Year ending June 30, 1899.

Forms of Tender may be obtained on application to the undersigned.

Sealed Tenders to be sent to the Chairman on or before July 2, endorsed "Tar and Liquor."

JOS. C. INGHAM,
Manager.

Gas-Works, Ramsbottom,
June 24, 1898.

TO COAL CONTRACTORS AND OTHERS.

THE Sedgley Urban District Council invite TENDERS for supplying 500 to 1000 Tons of GAS COAL, the deliveries to be made at the Shut End Siding at such times and in such quantities as may be directed.

Sealed Tenders, marked "Coal," must reach me on or before the 6th of July next.

The Council do not bind themselves to accept the lowest or any Tender.

By order,
JOSEPH SMITH,
Clerk to the Council.

Offices: High Holborn,
Sedgley, June 11, 1898.

TO COLLIERY PROPRIETORS.

THE Directors of the Sheffield United Gaslight Company invite TENDERS for GAS COAL, NUTS, and CANNEL for delivery during Twelve Months to the 30th of June, 1899.

The Quantities required will be approximately—

Gas Coal and Nuts . . .	185,000 Tons.
Cannel	20,000 "

Tenders (forms for which can be obtained on application) must be delivered to the undersigned by post not later than the first post on Saturday, July 16.

The Directors do not bind themselves to accept the lowest or any Tender.

HANBURY THOMAS,
General Manager and Secretary.

Commercial Street, Sheffield,
June 25, 1898.

THE WALLINGFORD GASLIGHT AND COKE COMPANY, LIMITED.

TENDERS FOR GAS COAL.

THE Wallingford Gaslight and Coke Company, Limited, invite TENDERS for the supply for One Year, from the 13th of August next, of about 900 Tons of best screened GAS COAL, to be delivered free, at the Railway Station at Wallingford, in such quantities and at such times as the Company may require.

Payments monthly.

Sealed Tenders, endorsed "Tender for Gas Coal," to be delivered on or before the 30th of July next.

The Company do not bind themselves to accept the lowest or any Tender.

By order,
JOHN CARTHEW,
Secretary.

Wallingford, June 28, 1898.

CITY OF SHEFFIELD.

(WATER DEPARTMENT.)

LITTLE DON VALLEY NEW WATER-WORKS.
GENERAL STORES.

THE Water Committee of the Corporation of Sheffield invite TENDERS for the supply of GENERAL STORES in such quantities as may be required during Twelve Months ending July 31, 1899.

Schedule and Form of Tender may be obtained on application to the General Manager, Water Department, Town Hall, Sheffield, on payment of One Guinea, which will be returned on receipt of a *bonâ-fide* Tender.

Tenders, endorsed "Tender for Stores, Langsett," must be sent in not later than Saturday, the 9th of July, 1898, addressed to the undersigned.

The Committee do not bind themselves to accept the lowest or any Tender, and persons tendering must do so at their own Cost.

WM. TERREY,
General Manager.

Water-Works Office, Town Hall,
Sheffield, June 25, 1898.

THE GASLIGHT AND COKE COMPANY.

NOTICE is Hereby Given, that the TRANSFER BOOKS of this Company, so far as they relate to CAPITAL STOCKS, WILL BE CLOSED at Four o'clock p.m., on Tuesday, the 5th day of July next, and will be RE-OPENED immediately after the Half-Yearly General Meeting of the Company, to be held on the 5th day of August next.

By order,
JOHN WILLIAM FIELD,
Secretary and General Manager.

Chief Office: Horseferry Road,
Westminster, S.W., June 24, 1898.

SALES BY AUCTION OF GAS AND WATER STOCKS AND SHARES.

MR. ALFRED RICHARDS begs to notify that his AUCTIONS of STOCKS and SHARES in London, Suburban, and Provincial Gas and Water Companies are held MONTHLY, at the Mart, Tokenhouse Yard, E.C.

He also undertakes the issuing by Auction of Gas and Water Stocks and Shares under Parliamentary Powers.

Terms for issuing such Capital, and also for including Gas and Water Stocks and Shares in these periodical Sales, can be obtained on application at Mr. Alfred Richards's Offices, 18, FINSBURY CIRCUS, E.C.

By order of the Directors.

BRENTFORD GAS COMPANY.

£15,000 OF NEW STOCK 1881.

Ranking for a Standard Dividend of 7 per cent. per annum subject to the Sliding-Scale; the last Dividend on similar Stock having been at the rate of 9 per cent.

MR. ALFRED RICHARDS will Sell the above BY AUCTION, at the Mart, Tokenhouse Yard, E.C., on Monday, July 18, at Two o'clock precisely, in Lots.

Particulars may be obtained of the SECRETARY of the Company, at the Offices, BRENTFORD; and of the AUCTIONEER, 18, FINSBURY CIRCUS, E.C.

By order of the Directors.

CRYSTAL PALACE DISTRICT GAS COMPANY.

MR. ALFRED RICHARDS will Sell BY AUCTION, at the Mart, E.C., on Wednesday, June 29, at Two o'clock, in Lots.

£20,000 FIVE PER CENT. PERPETUAL DEBENTURE STOCK
OF THE
CRYSTAL PALACE DISTRICT GAS COMPANY,

To be created under the Provisions of the Crystal Palace District Gas Act, 1893.

Particulars at the COMPANY'S OFFICES, LOWER SYDENHAM, and of the AUCTIONEER, 18, FINSBURY CIRCUS, E.C.

By order of the Directors.

GUILDFORD GASLIGHT AND COKE COMPANY.

MR. ALFRED RICHARDS will Sell by AUCTION, at the Mart, E.C., on Monday, July 4, at Two o'clock.

£5000 of ORDINARY STOCK
IN THE
GUILDFORD GASLIGHT & COKE COMPANY,

Ranking for a Standard Dividend of 5 per cent.; the last Dividend on similar Stock having been at this rate.

Particulars of the AUCTIONEER, 18, FINSBURY CIRCUS, E.C.

By order of the Directors.

SOUTHEND GAS COMPANY.

850 £10 SHARES.

Ranking for a Standard Dividend of 7 per cent. subject to the Sliding-Scale; the last Dividend on similar Shares having been 7½ per cent.

MR. ALFRED RICHARDS will Sell the above BY AUCTION, at the Mart, E.C., on Monday, July 4, at Two o'clock, in Lots.

Particulars at the COMPANY'S OFFICES, SOUTHEND; and of the AUCTIONEER, 18, FINSBURY CIRCUS, E.C.

By order of the Directors.

WHITCHURCH AND DISTRICT (HANTS) GAS COMPANY, LIMITED.

MR. ALFRED RICHARDS will Sell BY AUCTION, at the Mart, E.C., on Monday, July 4, at Two o'clock.

150 £10 FULLY-PAID ORDINARY SHARES
IN THE
ABOVE UNDERTAKING.

Particulars of the AUCTIONEER, 18, FINSBURY CIRCUS, E.C.

By order of the Executors of the late John Young, Esq.

DORKING GAS COMPANY.

FIFTY £25 FULLY-PAID "A," "B," & "C" SHARES.

MR. ALFRED RICHARDS will Sell the above BY AUCTION, at the Mart, E.C., on Monday, July 4, at Two o'clock, in Lots.

Particulars of the AUCTIONEER, 18, FINSBURY CIRCUS, E.C.

AUTOMATIC METER REGISTER

The Meter Life Book specially adapted, and revised for "Slot" Meter Registration by

ROBERT P. KEYS.

In sizes to record 1000 Meters, with Index, Half Bound	£2 2 0
To record 500 Meters	£1 15 0
To record 250 Meters	£1 11 6

The only Easy System yet projected.

PUBLISHED BY
WALTER KING, 11, Bolt Court, Fleet Street, E.C.

CRYSTAL PALACE DISTRICT GAS COMPANY.

SALE BY AUCTION OF £20,000 FIVE PER CENT. PERPETUAL DEBENTURE STOCK.

NOTICE is Hereby Given, that the Directors have instructed Mr. Alfred Richards, to SELL BY AUCTION, at the Mart, Tokenhouse Yard, E.C., on the 29th day of June next, at Two o'clock in the Afternoon precisely, in Lots, £20,000 of FIVE PER CENT. PERPETUAL DEBENTURE STOCK OF THE COMPANY, pursuant to the Powers contained in the Crystal Palace District Gas Act, 1893 (56 & 57 Vic.), and the Resolution passed at a Meeting of Proprietors.

Purchasers to make full payment before the 13th day of July, from which date Interest will accrue, payable on the 15th day of January and the 15th day of July in each year, calculated to the expiration of the preceding Half Year.

Particulars and Conditions of Sale can be obtained at the Offices of the Company, Lower Sydenham, London, S.E.; of the Solicitors, Messrs. Blyth, Dutton, Hartley, and Blyth, 112, Gresham House, Old Broad Street, E.C.; and of the Auctioneer, 19, Finsbury Circus, E.C.

By order of the Board,
CHARLES M. OHREN,
Secretary.

Offices and Works:
Lower Sydenham, S.E.,
May 27, 1898.

PRICE'S COKE & COAL BARROW

effects a great saving of time, labour, and expense.

For Particulars, Price, &c., apply to Mr. EDWARD PRICE, 119, Queen's Road, FINSBURY PARK, N.

Prices are Reduced.

WORKMEN'S COMPENSATION ACT.

In connection with the above Act and the Employers' Liability Act, 1880, the

RAILWAY PASSENGERS ASSURANCE COMPANY

are prepared to undertake the whole liability imposed upon Gas Companies, together with the Common Law liability to the extent of Three Years' Wages.

Established 1849.

Capital fully subscribed £1,000,000.

CLAIMS PAID, CLOSE ON £4,000,000.

Particulars from W. H. HARVEY,
17, OLD QUEEN STREET, WESTMINSTER,
LONDON, S.W.

UNEQUALLED.

Gas Companies are solicited to try Samples of the

MIRFIELD
BLACK BED GAS COAL.

Prices and Analysis on application.

MIRFIELD (GAS-COAL) COLLIERY COMPY.
RAVENSTHORPE, NEAR DEWSBURY.

Lanemark Coal Co.,
LIMITED.

LANEMARK CANNEL
AND GAS COALS.

Quotations and Analysis on Application to

LANEMARK COLLIERY,
NEW CUMNOCK, N.B.

Shipping Ports: All the principal Scotch Ports.

Ready this Day—450 Pages, Crown 8vo., with numerous Illustrations, 10s. 6d. Leather.

THE
GAS ENGINEER'S
POCKET BOOK,

Comprising Tables, Notes, and Memoranda relating to the Manufacture, Distribution, and Use of Coal Gas, and the Construction of Gas-Works.

By HENRY O'CONNOR, Assoc.M Inst.C.E.

London: CROSBY LOCKWOOD & SON,
7, STATIONERS' HALL COURT, E.C.

HEBBURN MAIN GAS COALS.

Yield of Gas per ton . . . . . 10,500 cub. ft.
Illuminating Power . . . . . 16·4 candles.
Coke . . . . . 68 per cent.

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W. RICHARDSON, Fitter.

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THIS Material is of full Strength, and Exceptional Activity. It is specially prepared to minimize Back-Pressure; and will be supplied on Hire, or Sold, on the most favourable Terms.

SPENT OXIDES containing Blue, also CRUDE FERRO-CYANIDE PRODUCTS, either PURCHASED or EXCHANGED for FRESH OXIDE.

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LONDONDERRY GAS COALS
FROM THE
MARQUIS OF LONDONDERRY'S COLLIERIES,
COUNTY OF DURHAM.

Available output up to 5000 tons per day.
Yield of Gas 11,000 cubic feet per ton of Coal as per analysis by
Mr. John Pattinson, F.C.S., F.I.S.

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OUGHTIBRIDGE, near SHEFFIELD,
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SILICA BLOCKS,
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OF SUPERIOR QUALITY
FOR GAS-FURNACES.

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Strongly recommended where EXCESSIVE HEATS have to be maintained.

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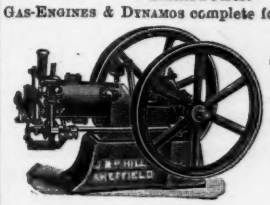
GAS-ENGINES & DYNAMOS complete for HOTEL, HOUSE, and SHOP Installations.



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5/6 Combines High Illuminating Power and Great Economy of Gas with a Soft Pleasant Light.
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ANALYSIS.

Yield of Gas per ton . .	10,500	Cubic Feet.
Illuminating Power . .	16·9	Candles.
Coke	66·7	Coke.
Sulphur	0·86	Sulphur.
Ash	2·04	Ash.

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Present Daily Produce over 5000 Tons.

Latest Analysis—By CHARLES PHILLIPS, Gas Examiner to Rotherham Corporation

Yield of Gas per Ton . . .	11,205 Cubic Feet.
Illuminating Power	16.7/10 Stand. Sperm. Candl.
Coke (of good & pure quality)	13¾ Cwt. per Ton.
Sulphur	A little over 1 per Cent.
Ash	Under 1 per Cent.
Tar	163 lbs. (Avoir.) per Ton.
Ammoniacal Liquor	103 lbs. (Avoir.) per Ton.

HOLMSIDE GAS COALS are supplied to the largest Gas Companies in England and on the European Continent; London alone consuming about half the produce.

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Present Daily Produce available 3000 Tons.

Of equal quality to the "Holmside" Coal, and also very largely used by many Gas Companies at Home and Abroad.

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MANUFACTURERS OF
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GLAZED BRICKS AND PORCELAIN BATHS.

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UPPER GROUND STREET, LONDON, S.E.,
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AND ALL KINDS OF GAS-WORKS APPARATUS.
SOCKET-PIPES FOR GAS OR WATER PURPOSES.
FLANGE PIPES FOR STEAM.
Sole Manufacturers of LYON'S "PATENT" GAS-MAIN SYPHONS.
AGENTS FOR
ATTERTON'S PATENT APPARATUS for CHARGING RETORTS.

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GAS COAL AND CANNEL FACTORS,
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UNDOUBTEDLY
THE COOKER
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("A" Series)

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CAST-IRON CASE.

The Advantages of this System are:

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3. Impossibility of being tampered with.
4. Unaffected by irregularities in shape or thickness of the penny.
5. Can be fixed to any ordinary Wet or Dry Meter.
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7. Price Changer can be altered without otherwise disturbing Meter.
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Special attention is called to the advantage of this Meter both to the Consumer and the Gas Company, in its correctness of registration; the construction of the Mechanism being such as to ensure the exact correspondence of amount due per Index and Cash in Money-Box.

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Of all Kinds

For GAS-WORKS.

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Regenerative Settings of Gas-Retorts.

— G. R. HISLOP'S PATENTS. —

A Perfect System. Results Guaranteed.

Erected upon the Stage Floor or Shallow-Chamber Plan, to suit local circumstances or applied to existing Ovens.

PRACTICAL RESULTS.

Retorts of ordinary Section, 22 in. by 15 in., produce, with facility, the record quantity of 1000 cubic feet of Gas per lineal foot of Retort with English Coal, and 1250 cubic feet with Scotch Coal per 24 hours, or carbonize 17 to 20 cwt. of English, and 20 to 25 cwt. of Scotch Coal per 24 hours, depending upon the length of the Retorts and the nature of the Coal—Fuel account being 10 to 12 lbs. per 100 lbs. of Coal carbonized. The whole of the Materials employed are of the highest Fire-Resisting Class procurable; thus necessitating a small outlay for maintenance. The Waste Gases from the Setting are fully utilized in raising Steam for the Producers, while the latter require cleaning once only in 48 hours to twice weekly, under the use of English Coal. They are easily managed; and, under latest improvements, there is absolutely no clinkering or use of bars necessary. **Theoretically and practically, the most perfect Producer in the market;** and, filled direct from the Retorts through patent Self-Sealing Shoot, all luted doors or covers, and portable shoots dispensed with. **There is no fracturing of the Regenerators; these being absolutely sound for nine to twelve years.** Entire cost of erection returned in profit in from twelve to eighteen months' working.

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Under G. R. Hislop's Patents, all Spent Limes are effectively recovered at from one-third to one-half the Cost of New Lime.

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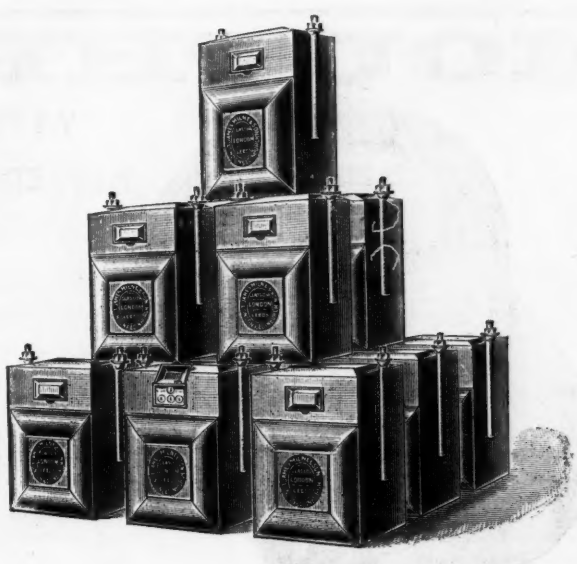

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Fig.307. Fig.1A. Fig.34. Fig.46. Fig.160M. Fig.185. Fig.222. Fig.256. Fig.69. Fig.102. Fig.328.

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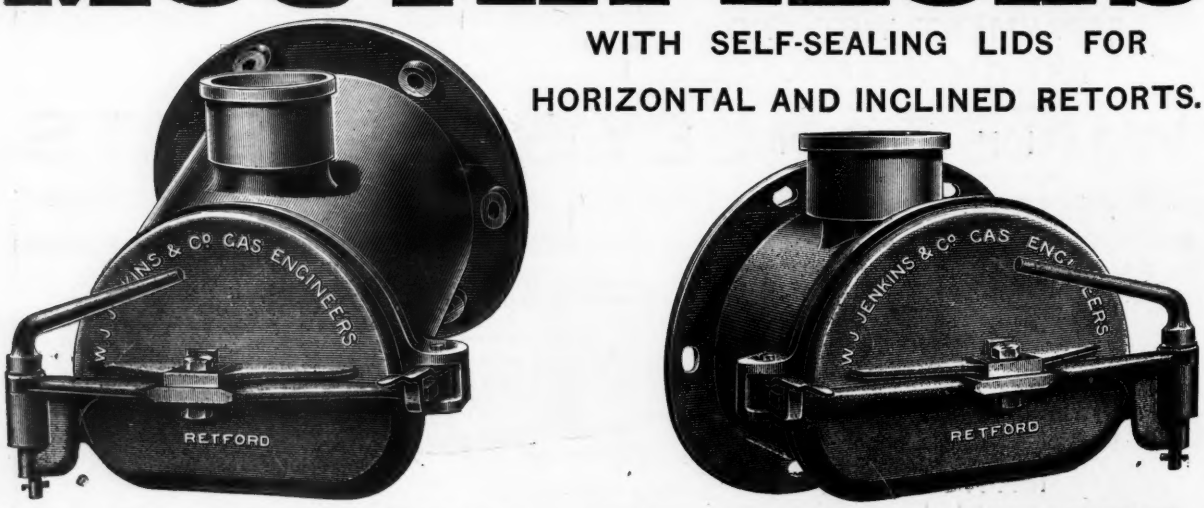

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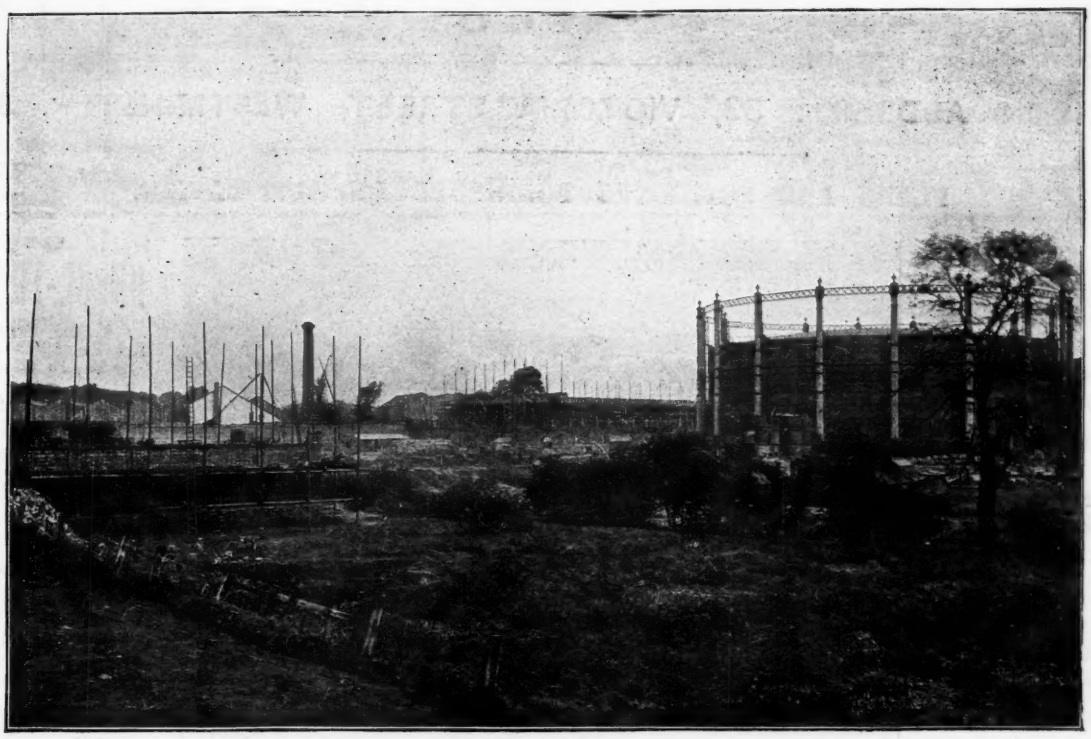

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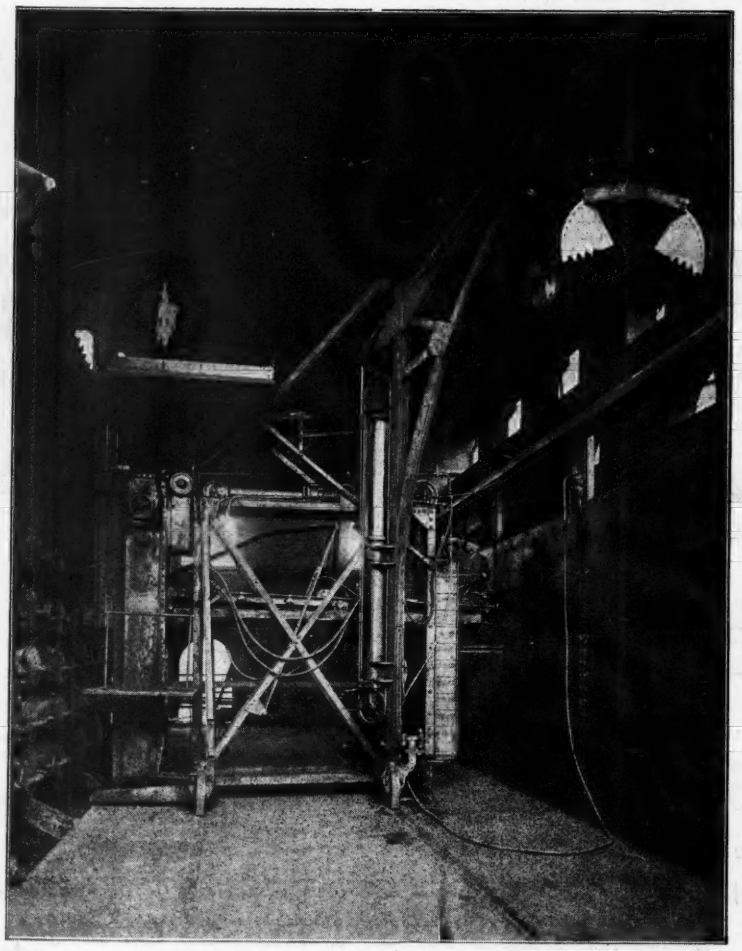

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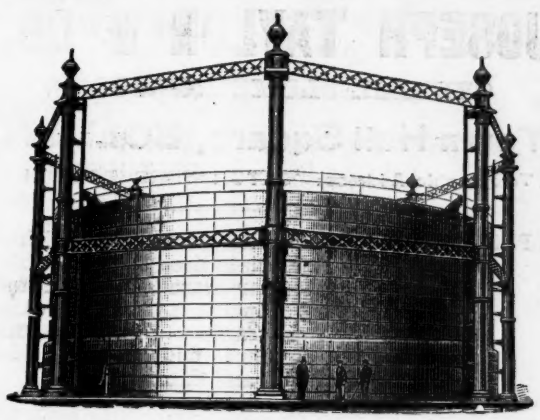

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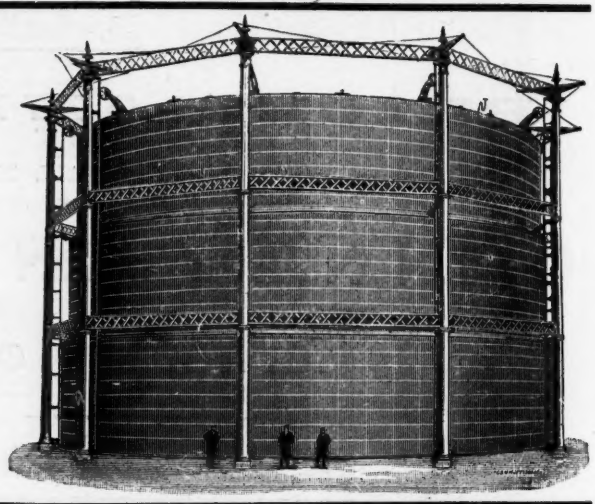

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Hand-worked from Solid Plate Lead. Two Vertical Seams only.

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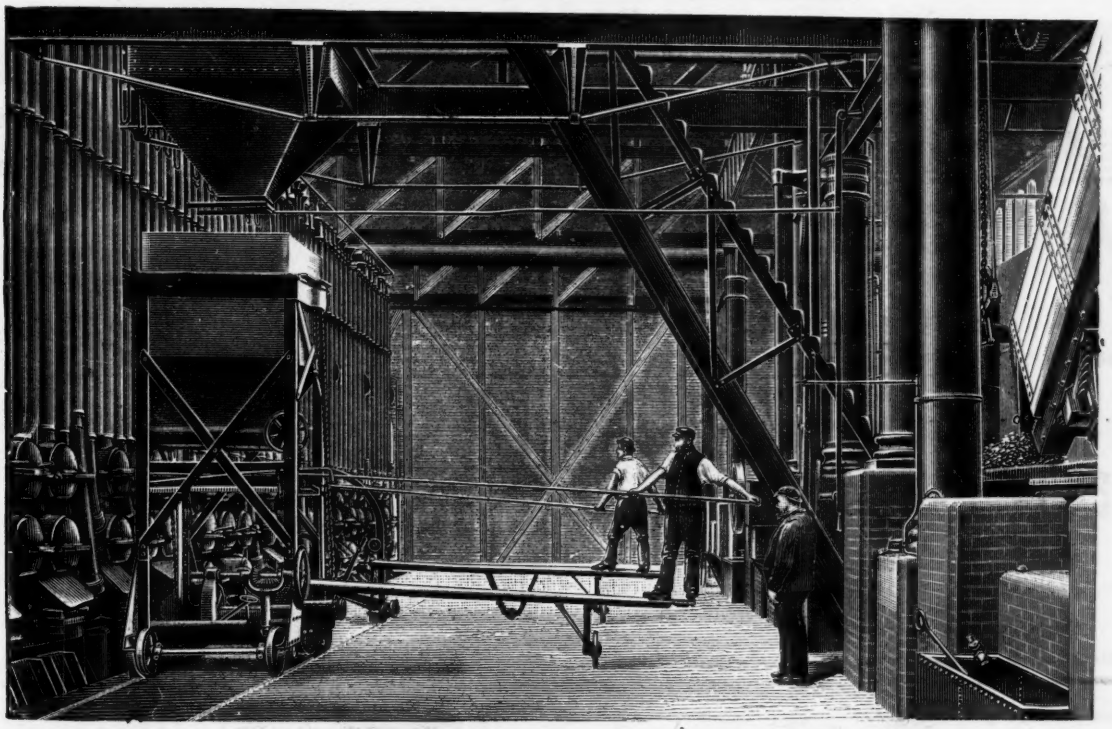

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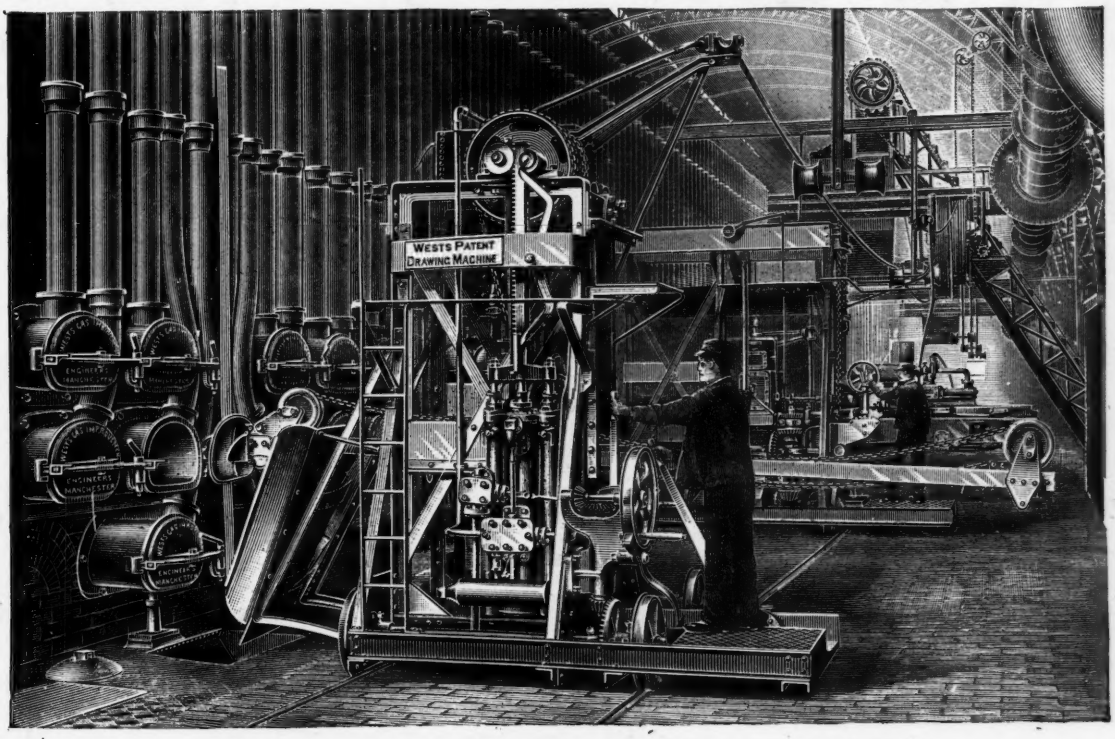

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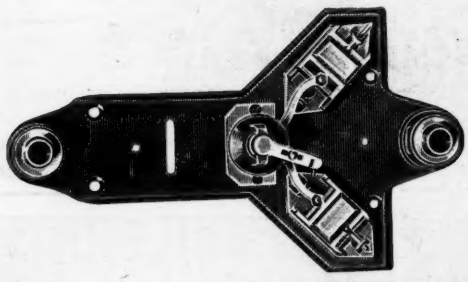
Specially Suited for Use with Gas-Engines.

Dry Meter in Cast-Iron Case for 5 Lights.



VIEW OF GAS-PASSAGE SHOWING THE TOP MOUNTING.

THE SIZES RANGE FROM 1 LIGHT TO 150 LIGHTS.

The merit of this Meter lies in its simplicity.

Repairs can be effected without the aid of skilled labour.

The Gas Passage is formed of a single casting, on which the whole top fittings are mounted.

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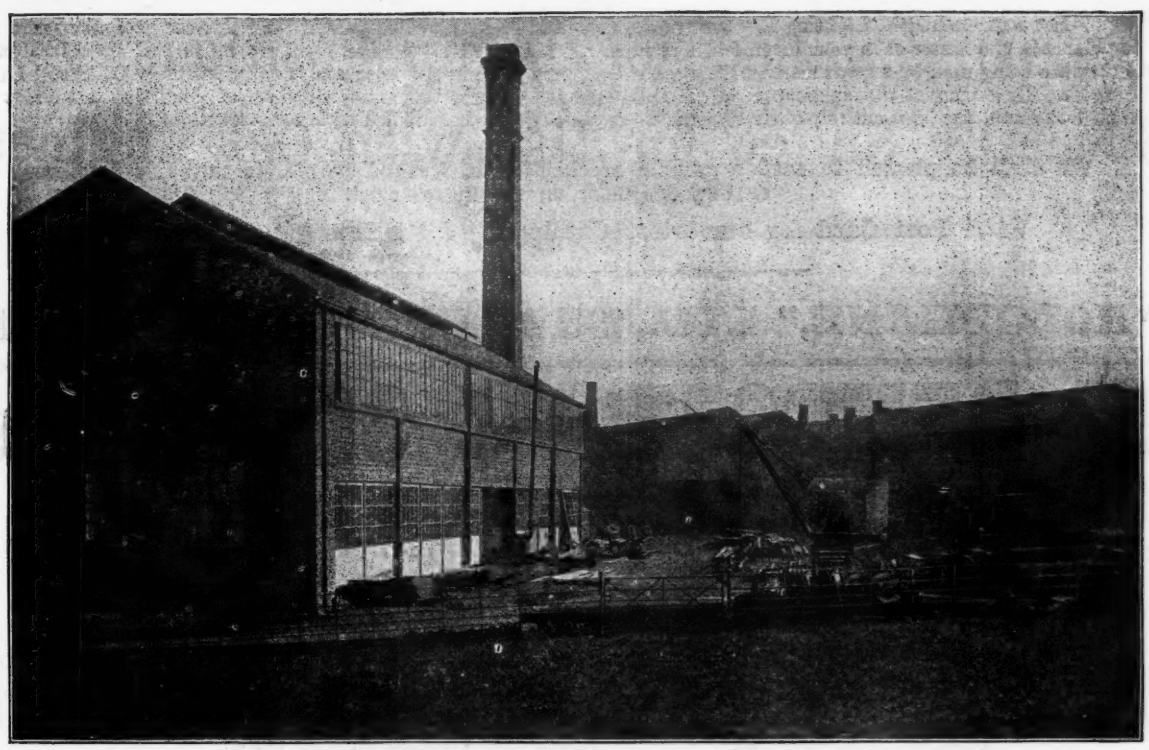

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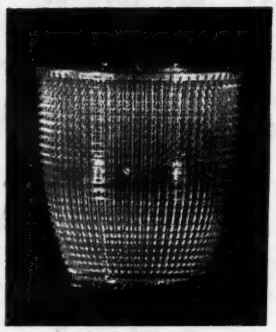
New Pattern No. 52 for Street Lighting with Welsbach "C" Burner.



5000 of these Globes now in use in the Streets of Munich.

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Mr. UPPENBORN, Lighting Engineer of the City of MUNICH, writes as follows: "You are no doubt aware that I have taken a vivid interest in your invention, known as 'HOLOPHANE' Globes. I have introduced them in Munich, and they are being used by a great many private individuals; further, in Schools; and, finally, in the 4900 Street-Lamps of Munich. By reason of the application of 'HOLOPHANE' Globes, the annoying glare of the light, as well as the shadow formation, has been entirely obviated; and we may now justly be satisfied with our street lighting."

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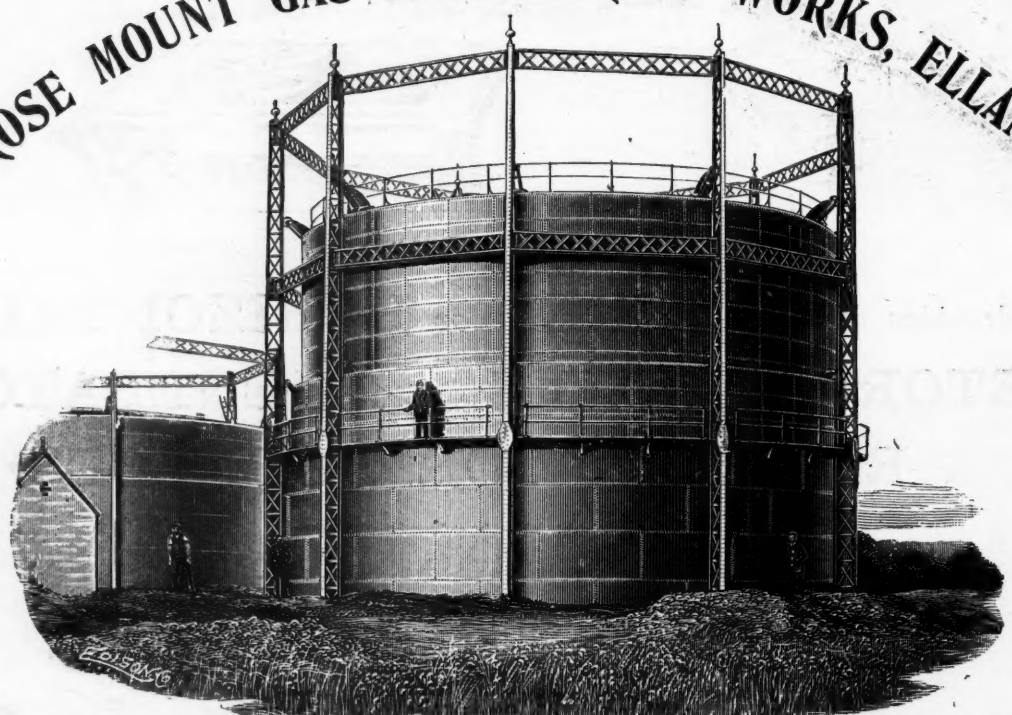

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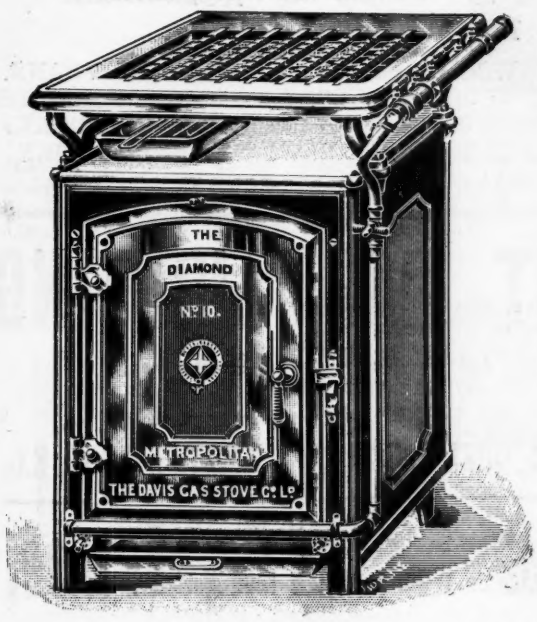
THERE IS NOTHING NEWER, NOTHING BETTER.

All Modern Improvements that ARE Improvements embodied, and new features of real value both to Gas Managers and Gas Consumers introduced. Remember that "Economy in Gas Consumption" is our Watchword.

SHOWN WITH DOOR CLOSED.



IN designing the above, we have done away with all those small loose pieces which are liable to breakage, and have kept in view the points of strength, stability, compactness, and capability of being readily repaired.

All parts are easily accessible for cleaning without the stove being disconnected; and, throughout—wherever screws are used—thick wrought-iron nuts are cast in to prevent the danger of the thread stripping.

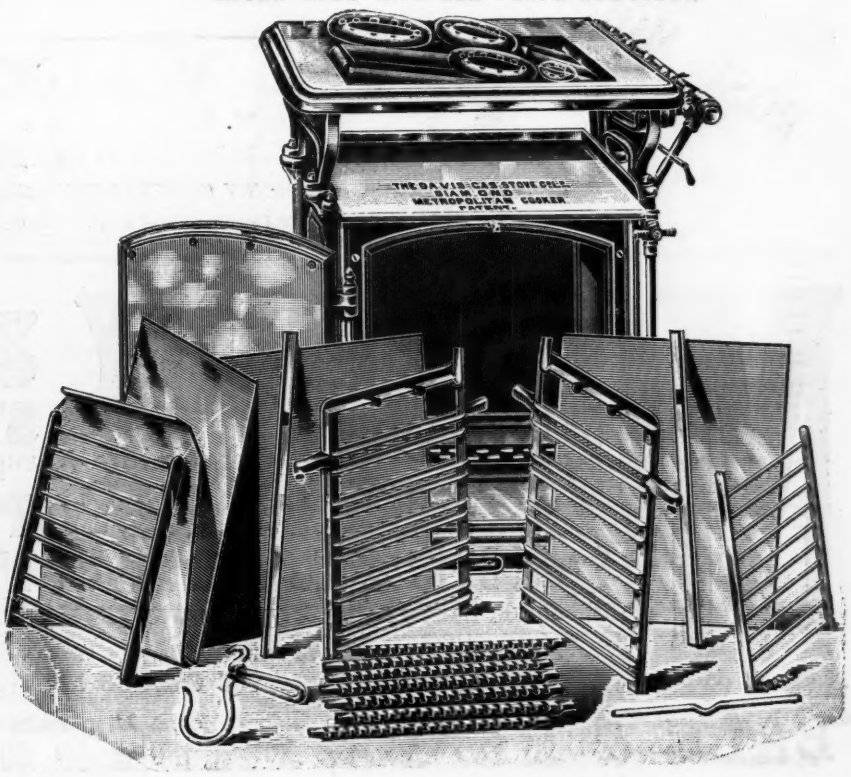
Hot-Plate Burners.—These are of cast iron and removable; but are held in position by a sliding locking bar, which holds them securely in their places so that they can be neither lifted nor shaken out when in use. They require neither cross bars nor supports (which always collect dirt and take up space) to sustain them.

Removable White Tops.—White Enamelled Top Plates are now considered an essential part of an up-to-date Cooker. This is a **really good, loose enamelled** slide-in top plate, running in a groove specially provided. It covers the **whole** of the top of the stove, and is entirely devoid of screw holes. In view of the fact that, for want of care in usage, the white enamelled tops sometimes become discoloured, while the stove is otherwise in good condition, and taking into consideration the fact that the top can only be replaced (always at considerable expense) by taking the Cooker to pieces, the improvement, by which an old plate can be exchanged for a new one at what is practically a nominal cost, is one which should carry weight in the judgment of intending purchasers, and especially in the case of Managers of Gas Undertakings.

Loose Enamelled Linings.—We have here quite a new feature, and this improvement is one well worthy of attention. It must be remembered that the body of the stove is made up of cast-iron exterior and interior plates packed between with non-conductor, and the loose enamelled linings are additional to the others. They are readily removed, and cannot become fixed, nor can they warp and so jamb the grid shelves, being automatically held in place by the hanging runners. The top of the oven is double, and packed and fitted with sliding damper to regulate the heat; and the inside top plate is studded to retain and diffuse it in the upper part of the oven. The outlet is central at the back so that flue-pipe can be taken in any direction.

The Oven Burners are loose and easily cleaned, being protected from falling fat by cast-iron splash-plates, which also prevent the bottom of the enamelled linings from becoming pulverized through the action of the flame.

SHOWN OPEN WITH ALL PARTS REMOVED.



No.	Inside Dimensions of Roaster.			Number of Burners on Hot Plate.
	Wide. Inches.	Deep. Inches.	High. Inches.	
7	12	12½	22	3
8	12	12½	24½	3
9	14	14	26½	4
9a*	..	..	..	..
10	17	17	27½	5
10a*	..	..	..	..
11*	..	..	..	..

No.	Required Space.			Prices including Deflector for Toast'g Apparatus
	Wide. Inches.	Deep. Inches.	High. Inches.	£ s. d.
7	21½	19	31	4 12 6
8	22½	20	33	5 7 6
9	25	22½	35	6 10 0
9a*	..	..	..	7 10 0
10	28½	26	36	8 10 0
10a*	..	..	..	9 10 0
11*	..	..	..	12 15 0

* These Sizes are in course of construction.

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which are the next best thing to UNBREAKABLE MANTLES.
The Illustrations show two of our arrangements; but we are able to cope with all conceivable conditions or requirements.
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WARNING: As we hold the Master Patents covering the COILING OF SUPPLY-PIPES to obtain a resilient bearing to neutralize the damaging effect of Shock or Vibration on the Mantles of Incandescent Burners, we shall not hesitate to immediately INSTITUTE PROCEEDINGS AGAINST ANYONE INFRINGING OUR RIGHTS.
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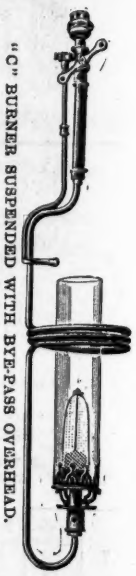
London Representatives: Messrs. HENRY GREENE & SONS, 153 & 155, Cannon Street, E.C.
Telegrams: "CLAYS, BOLTON." See Illustrated Advt. in "Journal," Nov. 30, 1897, p. 1155.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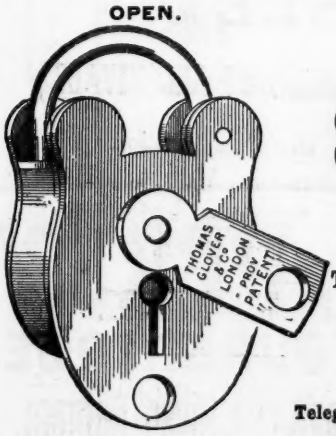

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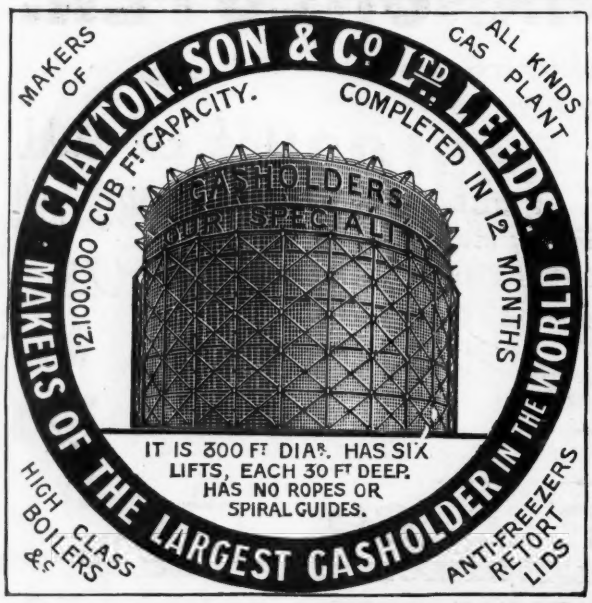
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which speaks for itself.

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and Bandsept, who was the first to adopt the Injector Principle, is

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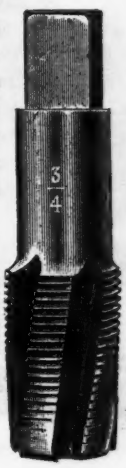

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[See also Advt. p. 1526

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